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ELF Communications System Ecological Monitoring Program: Wisconsin Bird Studies -- Final Report

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This study was designed to isolate effects of electromagnetic (EM) fields produced by extremely low frequency (ELF) antenna systems on bird species breeding in or migrating through Wisconsin. Specifically, the aim was to determine any differences in bird species richness and abundance between areas close to the antenna and those far enough away to be unaffected by the antenna. Characteristics examined included total species richness and abundance, abundance of common bird species, and abundance of birds within selected guilds. Measurements of vegetation identified differences and similarities between control and treatment areas. Habitat variables were used in analysis of covariance (ANCOVA) to compare numbers of abundant bird species in control versus treatment areas after adjustments for habitat differences.

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19. ABSTRACT (Continued)

No consistent patterns occurred to demonstrate that birds were either attracted to or repelled by EM fields produced by the antenna. Most differences in abundance between control and treatment areas could be attributed to habitat differences (both in ANCOVA and in guild analysis). Based on tests of transects paired by habitat similarities, the presence of the antenna right-of-way (ROW) may have affected abundance of some bird species in the study areas. Abundance of species related to edges was higher in treatment areas, particularly during May and June. Differences between sites in the abundance of species that prefer forest interiors were less pronounced than for those species preferring edge habitat. Since data on bird populations were not collected prior to construction and intermittent operation of the Wisconsin transmitter, "before and after" comparisons were not made. However, data have been collected prior to construction and operation of the Michigan transmitter. These preoperational data, coupled with data collected during full operation, will be used for both temporal and spatial comparisons of Michigan bird populations.

FOREWORD

The study of bird ecology is one of several projects in the ELF Ecological Monitoring Program. The purpose of the program is to examine for possible electromagnetic effects on resident biota from operation of the U.S. Navy's Extremely Low Frequency (ELF) Communications System. IIT Research Institute (IITRI), a not-for-profit organization, has been contracted by the Space and Naval Warfare Systems Command (SPAWAR) to provide engineering support and to manage the program. The studies of bird ecology were conducted under subcontract arrangements between IITRI and the University of Minnesota-Duluth (UMD).

These studies were originally funded in 1984 to examine for possible effects on birds that were year-round residents in forests adjacent to ELF transmitters in both Michigan and Wisconsin. In 1986, the scope of the study was expanded to also examine for possible effects on birds migrating to, or through, the same areas. The Wisconsin transmitter became fully operational in October 1985. After five years of data collection, studies in Wisconsin were concluded in 1989 as scheduled. The findings of the Wisconsin studies are presented in this report. The Michigan transmitter became fully operational during October 1989. Data collection at Michigan sites is ongoing, and findings from these studies will be documented as a separate report upon completion of the project.

This report documents the results and conclusions of the Wisconsin portion of the study based on data collected over the term of the project. A draft text was reviewed by several peers with experience in such areas as bird ecology, statistics, and electromagnetics. The authors considered, and addressed, peer critiques prior to submitting a revised manuscript to IITRI for publication. Except for added prefatory and title pages, the manuscript is presented here without further change or editing by IITRI or SPAWAR.

Respectfully submitted,

IIT RESEARCH INSTITUTE

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ELF COMMUNICATIONS SYSTEM ECOLOGICAL MONITORING PROGRAM:

BIRD SPECIES AND COMMUNITIES

WISCONSIN TEST FACILITY

FINAL REPORT

SUBCONTRACT E06595-88-C-011

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ABSTRACT

This report summarizes work completed in a study that was designed to isolate effects of electromagnetic (EM) fields produced by extremely low frequency (ELF) antenna systems on bird species breeding in or migrating through Wisconsin. Specifically, the objective was to determine if bird species richness and abundance differed between areas that were close to the antenna and those that were far enough away to be unaffected by the antenna. Characteristics examined included total species richness and abundance, abundance of common bird species, and abundance of birds within selected guilds. Vegetation was measured to identify differences and similarities between control and treatment areas, and habitat variables were used in analysis of covariance (ANCOVA) to compare abundant bird species' numbers between control and treatment areas after they were adjusted for habitat differences.

The study showed no consistent patterns that would demonstrate that birds were either attracted to or repelled by EM fields produced by the antenna. Most differences in abundance between control and treatment areas could be attributed to habitat differences (both in ANCOVA and in guild analysis). Based on tests of transects paired by habitat similarities, the presence of the antenna right-of-way (ROW) may have affected abundance of some bird species in the study areas. Abundance of species related to edges was higher in treatment areas particularly during May and June. Differences in abundance of individuals that require forest interiors between control and treatment areas were not as pronounced. Because "before" data in Wisconsin are lacking, the possibility remains that these differences between control and treatment existed before the ROW was cut; such comparisons, however, will be possible in the Michigan study.

SUMMARY

This report summarizes work completed for an investigation designed to isolate effects of electromagnetic (EM) fields produced by extremely low frequency (ELF) antenna systems on bird species breeding in or migrating through Wisconsin. Specfically, the objective was to determine if bird species richness and abundance differed between areas that were close to the antennas and those that were far enough away to be unaffected by the antenna. We pursued this question at both the community and species level. Characteristics examined included total species richness and abundance, abundance of common bird species, and abundance of birds within selected guilds. The monitoring program included bird censuses over a five-month period from May to September (1986-1989). Additional data were collected in June of 1985 and August-September of 1984, all while the antenna was fully or partially operational.

EM fields associated with the antenna (76 Hz) were an order of magnitude higher on treatment than on control sites; 60 Hz exposure was similar in control and treatment areas. No consistent patterns of positive or negative correlations with EM fields in treatment areas were noted for any individual species, community, or guild parameters.

Several differences in vegetation variables were detected between control and treatment study sites. The difference most likely to influence bird populations was distribution of coniferous and deciduous habitats. Treatment segments supported more coniferous and lowland habitats than did control areas. To account for differences in habitat between treatment and control segments in Wisconsin, we used habitat variables in analysis of covariance (ANCOVA) to adjust bird species

abundances. Habitat variables (maximum of five) were selected by multiple regression for each species in each year and month.

Bird abundance and species diversity were highest in May and June; more species were observed on treatment relative to control areas in June and July. Considerable annual variation in numbers of individuals and species was noted.

Overall (after ANCOVA), we detected differences in abundance for 38 individual species between control and treatment areas: 19 species were more abundant in control areas, 16 were more abundant in treatment areas, and 3 species were not consistently more abundant in either control or treatment areas. Most species that were more abundant on either treatment or control area (32 of 38) were "common" (mean < 1 individual/500 m) species; the ANCOVA successfully accounted for differences in abundance in 62% of the "abundant" (mean ≥ 1 individual/500 m) species comparisons. Few species were consistently and significantly more abundant on either treatment or control segments among seasons within a year or within seasons between years.

Distributions of three species--the indigo bunting, red-eyed vireo, and northern parula--were possibly affected by the right-of-way (ROW). The first two species were more abundant on treatment transects and more abundant on the antenna side of treatment transects; the northern parula showed the opposite pattern. Based on tests of transects paired by habitat similarities, the presence of the antenna ROW may have affected abundance of some bird species in the study areas. Abundance of species related to edges was higher in treatment areas particularly during May and June. Differences in abundance of individuals that require forest interiors between control and treatment areas were not as pronounced. However, because no "before" data are

available to enable comparisons, these differences may or may not have existed prior to the ROW clearing. Such comparisons will be made in the Michigan study.

Species were classified into guilds on the basis of foraging behavior and preferred breeding habitat. Few significant differences in abundances of birds within different guilds were found between treatment and control segments. Differences were most consistent for habitat categories, providing further evidence that habitat differences were responsible for many of the observed differences in bird distribution patterns between treatment and control segments.

INTRODUCTION

This report summarizes a five-year (1985-1989) field investigation designed to assess effects of the Navy's extremely low frequency (ELF) antenna system on birds breeding in or migrating through northwest Wisconsin. Birds are an important organism to consider in an assessment of electromagnetic (EM) field impacts because many can perceive slight changes in EM fields and they can use the earth's magnetic field for orientation during migration (Wiltschko and Wiltschko 1988). Effects of ELF (EM) fields on most aspects of a bird species' life history, however, are poorly understood (National Academy of Sciences 1977; Lee et al. 1979; other references in Hanowski et al. 1987). Several investigators have studied effects of transmission lines on structure and composition of bird communities; most have analyzed combined effects of habitat alteration and EM fields (Anderson et al. 1977; Anderson 1979; Dawson and Gates 1979; Meyers and Provost 1979; Stapleton and Kiviat 1979; Bell 1980; Bramble et al. 1984; Niemi and Hanowski 1984). Others have focused on effects of the right-of-way (ROW) edge (Chasko and Gates 1982; Kroodsma 1982), collision with lines (Beaulaurier et al. 1982), and audible noise generated by a transmission line (Lee and Griffith 1978).

This study, in contrast to previous ones, allows us to separate effects of EM fields on bird species and communities from effects due to direct habitat changes along the ROW. Specifically, we wanted to determine if bird species richness and abundance differed between areas close to the antenna from areas far enough away to be unaffected by the antenna. We pursued this question at both community and species levels by examining total species richness and abundance, abundances of common bird species, and abundances of birds within selected guilds. Our study included spring migration (May), early (June) and late (July) breeding, and early

(August) and late (September) fall migration. Potential effects of the ELF antenna on birds may vary among seasons. During migration, birds may be present on study areas for only brief periods. Conversely, breeding birds remain on territories longer (1-3 months), increasing their exposure to EM fields.

Two potential approaches are possible for assessing effects of the ELF antenna on bird communities. These are to (1) compare the affected area (treatment) with a similar control area or (2) conduct a before-and-after study. The antenna has been operating in Wisconsin periodically since 1969 and on a near continuous basis during our study. No pre-impact data on bird populations are available and, thus, we cannot assume that the antenna system has not already affected bird communities in Wisconsin. Consequently, it may not be relevant to compare control and treatment areas based on similarities in bird communities. We can, however, account for habitat differences in our analyses. We conducted a detailed habitat assessment in 1986 and 1987 to document habitat differences and similarities between control and treatment areas in Wisconsin. By incorporating analyses of habitat (with paired tests and analysis of covariance (ANCOVA)), we were able to more clearly isolate potential effects of the EM fields produced by the antenna.

Our rationale for using habitat structure to compare areas is based on the premise that birds select breeding areas (and, to a lesser extent, migration stop-over points) largely on the basis of vegetation structure (Lack 1933; Hilden 1965; James 1971; Cody 1985). Areas of similar vegetation should also have similar bird communities. Although this study design is not as desirable as the before-and-after design such as we are using in Michigan, studying potential effects in Wisconsin in concert with Michigan provides further insight into the potential long-term effects of the antenna on bird species and communities.

EXPERIMENTAL DESIGN

The first steps in the experimental design were to (1) evaluate techniques for quantifying bird community parameters and (2) determine sample sizes required to detect a specified difference between control and treatment areas. Four potential techniques were examined: transect counts, point counts, territorial mapping, and mist-netting. Territorial mapping and mist-netting were eliminated from consideration because of the amount of effort required to obtain statistically reliable results. We used transect counts because the ELF communications system consists of a long, linear network of the antenna and ROW and transects could be run parallel to this network. Point counts also could have been run adjacent to this network, but because we would walk along the swath adjacent to the ELF network, we decided to use the method that would include the larger census area (transects).

Birds were counted along a series of 500 m transect segments located near (treatment) or away from (control) the antenna. In an ideal experimental design, each 500 m segment should be randomly assigned to control and treatment areas. Logistically, however, this arrangement would be inefficient. To balance statistical rigor with the practicalities of working in the field, we grouped eight 500 m segments into one long transect (hereafter called transect). Each segment was separated by a buffer of 50 m to reduce autocorrelation between the experimental units (Figure 1). We used Moran's I statistic (Sokal and Oden 1978) to test spatial autocorrelation of adjacent segments. Results indicated that a 50 m buffer eliminated most autocorrelation between adjacent segments (Hanowski et al. 1990). We included eight 500 m segments into one line because previous experience indicated that bird count data should be gathered from one half hour before sunrise to about four hours after sunrise.

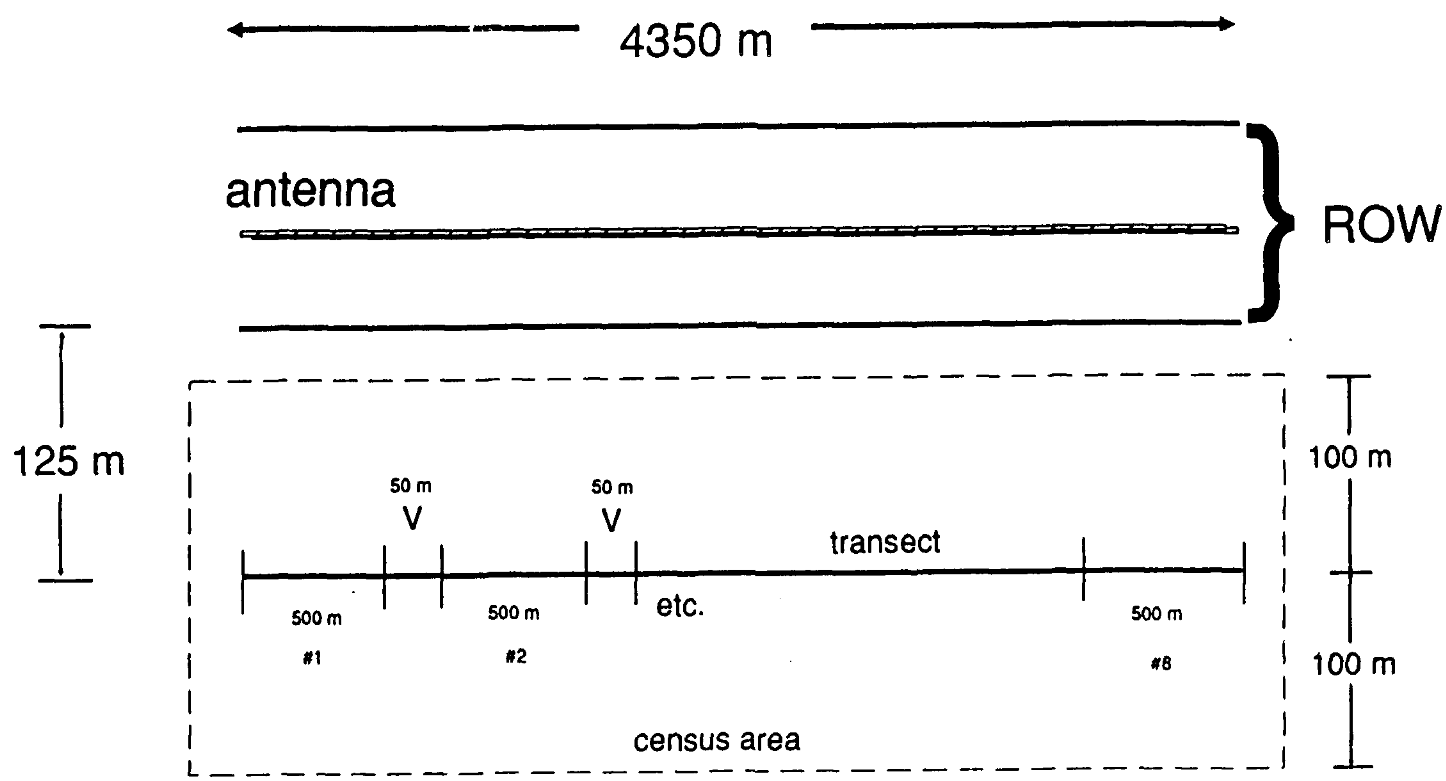

Figure 1. Schematic of a treatment transect layout. ROW = right-of-way.

A total of 4 hours and 35 minutes are needed to census eight segments and seven buffers (30 minutes for each segment and 3 minutes for each buffer). We estimated that 39 segments were needed in each group (control and treatment for each state) to detect a 15% difference in number of species (Hanowski et al. 1990). This percent difference was selected to reflect a difference of one species between control and treatment areas. Therefore, we selected five transect starting points per group or a total of 80 segments (40 segments per group).

Placement of treatment transects with respect to the ELF antenna system was designed to achieve two goals: (1) to reduce or eliminate potential effects of the ROW and ROW edge on the bird community (Chasko and Gates 1982); and (2) to maintain an appropriate EM field within the treatment area. We placed transects parallel to and 125 m from the edge of the ELF antenna ROW (Figure 1). This achieved a 25 m buffer between the ROW edge and limits the transect. Although this placement reduced the intensity of EM fields within treatment areas, EM fields still achieved the 10:1 ratio between treatment and control areas required in the study specifications (Brosh et al. 1986).

STUDY AREAS

We selected starting points for transects by numbering each possible starting location (by Township section) and then randomly selected numbers (5 control and 5 treatment) (Figure 2). Direction of travel from starting points was randomly determined. Electromagnetic fields were measured to insure that 76 Hz EM fields at a treatment site were significantly larger than: (1) 76 Hz EM fields at control sites, (2) 60 Hz fields at treatment sites, and (3) 60 Hz fields at control sites. In addition, exposure criteria required that there be no substantial difference in the ambient 60 Hz EM fields

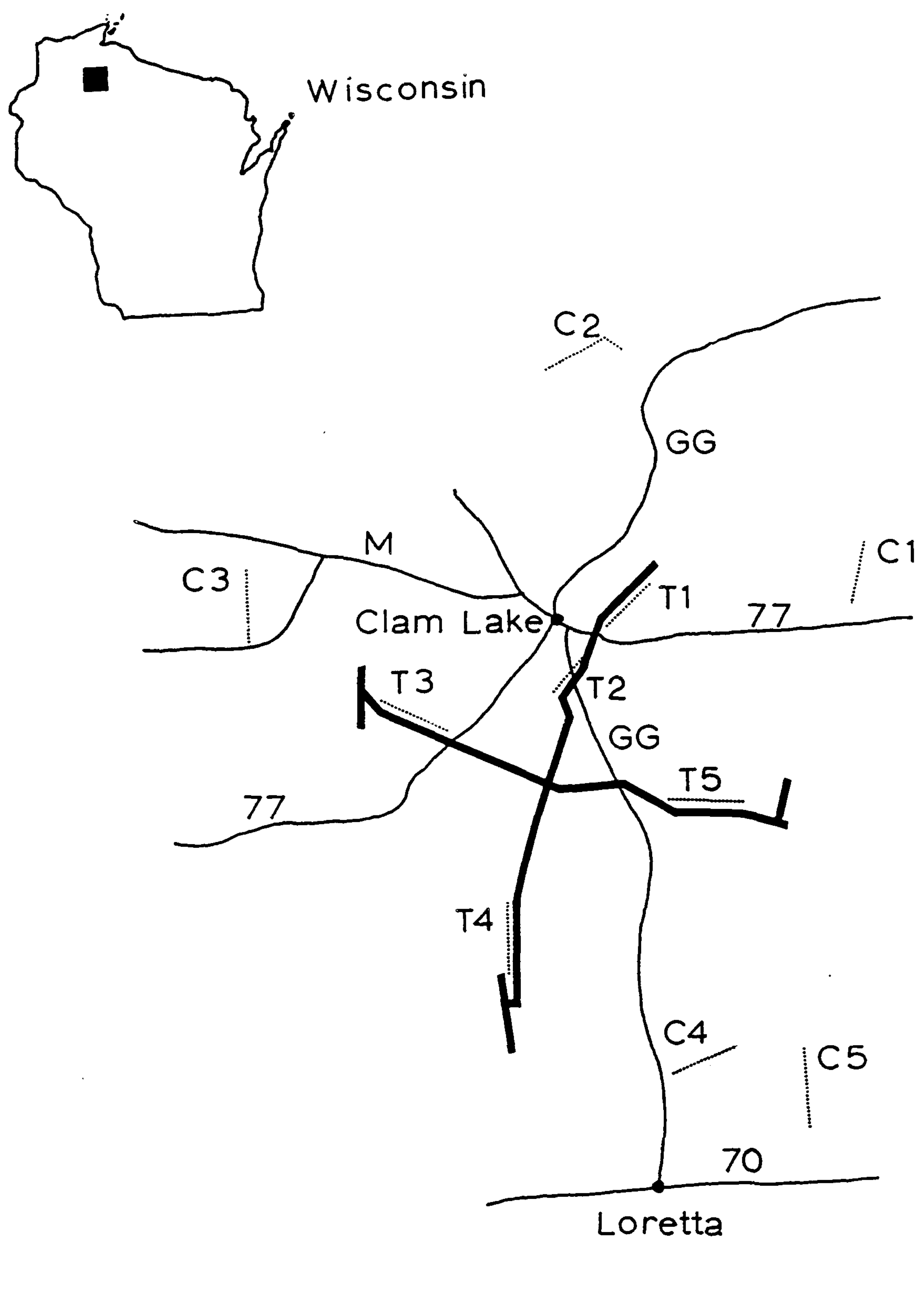

Figure 2. Locations of control (C1 to C5) and treatment (T1 to T5) transects in Wisconsin.

between control and treatment transects (Brosh et al. 1986). All transect pairs (control versus treatment) in Wisconsin fall within the "acceptable" category for EM field ratios established by IITRI. Electromagnetic fields were measured at the beginning and end of each control transect; they were not completed for each transect segment because most were not easily reached (e.g., most are 1-4 km from a road). In 1988 and 1989, EM fields were measured along entire treatment transects in Wisconsin (Haradem et al. 1989). These measurements provided a measure of how EM fields varied along the antenna and provided a value for each 500 m segment (Appendix 1).

Information regarding proposed logging along the transects was obtained from the U.S. Forest Service in Wisconsin. Because of the length of our transects, it was impossible to avoid areas affected by logging. Over six years, two control and five treatment transect segments were affected by logging. Some sites were selectively cut or thinned (Table 1). Analyses of annual variation in bird community composition revealed that slightly logged segments (< 5-20% of the segment) showed no greater difference between years than did unlogged sites. Segments that were logged over all or most of their length showed significantly greater differences in bird species composition between years than did unlogged segments. Consequently, our analyses of bird distribution patterns between years omitted segments logged over more than 20% of their length (one control and four treatment segments).

METHODS

BIRD COUNTS

We counted birds on line transects (Järvinen and Väisänen 1975) five times each year (May through September) from 0.5 hr before to 4.5 hrs after sunrise on days with little wind (< 15 km/hr) and no precipitation. Control and treatment transects

Table 1. Wisconsin transect locations and number of 500 m segments that were logged and dropped from annual variation comparisons (transects that were thinned were included in the analyses).

Number and Name		Township	Range	Sections	Number of 500 m segments affected
WISCONSIN					
C1	Spillerberg Lake	43N	3W	23,26,35	1
C2	Mineral Lake	44N	4W	15,16,17,18	0
C3	Rock Lake	42N	6W	6	0
		43N	6W	19,30,31	
C4	Blaisdell Lake	40N	4W	13,14,22,23	0
		40N	3W	18	
C5	Brunette River	40N	3W	16,21,28	1 (thinning)
T1	Woodtick Lake	43N	4W	22,23,27,28,33	0
T2	Little Clam Lake	42N	4W	5,8,17	0
T3	Christy Lake	42N	5W	7,8,15,16,17	1
T4	Black Lake	41N	5W	24,25,36	0
T5	Moose River	42N	3W	31	3

were sampled simultaneously by each of two observers to control for possible temporal variation in bird activity between areas. All observers were experienced in the identification of birds by sight and sound, and training sessions were conducted prior to censusing to standardize methods. Each observer walked at a rate of 1 km/hr and recorded the following information for each bird observed up to 100 m from the transect center line: (1) species, (2) estimated perpendicular distance from the transect in meters, and (3) distance along the transect in meters from the start. Birds flying above the canopy were not counted.

All transects were counted once in each season. We realize that some biological information may be lost (e.g., it is likely that some uncommon species were missed) by conducting only one count. However, based on previous analyses, we found that coefficients of variation of bird parameters increased when two counts were done (Hanowski and Niemi 1986). The increase was primarily due to temporal, weather, and observer related differences. We wanted to minimize the variance of our counts and, therefore, it was better statistically to gather data for more experimental units than to do multiple counts within experimental units (see Gates 1981; Hanowski et al. 1990).

We used the number of individuals observed along the transect in all data analyses instead of attempting to calculate a density value. Density could be calculated with a variety of formulae (Emlen 1971, 1977; Järvinen and Väisänen 1975; Burnham et al. 1981; Buckland 1985), but there are several assumptions that must be met before these methods can be used. A critical assumption is that distances are measured accurately; such measurements are difficult to obtain when birds are heard but not seen, as is true for most birds recorded during counts. Without accurate distance estimates these methods do not provide valid density estimates. Instead,

density estimates provide an index that may be no better than the original counts (Wilson and Bart 1985). In addition, density calculations are not needed in most investigations, especially when comparisons of "relative density" are less costly and allow the investigator to meet the objectives of the experiment (see Verner 1985). Here, we only assumed that number of birds recorded was related to bird density in an area (see Raphael 1987) and bird detectability was similar within control and treatment areas.

BIRD GUILDS

Birds observed in our study areas were classified by: (1) nesting site, (2) food or foraging method, (3) preferred breeding habitat, and (4) migration strategy (Appendix 2). Classifications were based on published sources (e.g., Martin et al. 1951; Bent 1963, 1964; Green and Niemi 1978; Terres 1982; AOU 1983, 1985) and personal observations. We used this information in analyses to address any differential effects of the ELF antenna on species that use particular feeding strategies, specific nesting areas, or different migration patterns (see Verner 1984).

VEGETATION

Vegetation on all segments was measured over a two-year period (1986 and 1987). A two year period was selected to more efficiently use personnel and to control for seasonal variation in vegetation growth.

Vegetation samples were gathered every 25 m along each segment. Sample points were positioned two meters from the transect line to avoid biases in where flag markers for transects were placed. We used methods that we have successfully used in past investigations to assess habitat characteristics (Niemi and Hanowski 1984; Niemi 1985); methods were modified from Wiens (1969) and Wiens and Rotenberry

(1981). Densities of trees, shrubs, forbs, and graminoids were calculated with the point-centered quarter method (Cottam and Curtis 1956). Vegetation variables measured and their descriptions are in Appendix 3.

STATISTICAL ANALYSES

Community parameters, abundant species, and guilds. We used a one-way analysis of variance (ANOVA) to test for differences between control and treatment transects within each season and year. Annual differences and treatment effects were examined with a two-way ANOVA (treatment and year) for the following variables: (1) abundant species, those with a mean of > one observation/500 m segment in control or treatment areas; (2) number of species observed in a 500 m segment; (3) number of individuals observed in a 500 m segment; and (4) numbers of individuals in representative guild categories. Because some segments were affected by logging after the initial census in 1985, we excluded these logged segments in the two-way ANOVAs. Variables were first examined for normality and homoscedasticity of variance prior to statistical analyses (Sokal and Rohlf 1981) and were transformed when necessary (e.g., logarithmic, square root) to reduce skewness, kurtosis, and heterogeneity of variances. Nonparametric tests (Kruskal-Wallis ANOVA) were used for variables that did not meet assumptions even after transformations.

Common species. We identified a second group of less abundant species ("common species") based on frequency of occurrence. These species had to be present on at least six segments during a season with the restriction that they occur on at least five control or five treatment transects (e.g., a species was not included if it occurred on

three control and three treatment segments). A prominence value (PV) was calculated for each species using the formula:

$$PV = D * F^{0.5},$$

where D = number of individuals observed and F = the relative frequency of species occurrence on treatment or control segments. Prominence values were calculated for control and treatment segments separately by season and year and differences were tested with a goodness-of-fit G-test or binomial test (Sokal and Rohlf 1981). The prominence value includes both frequency of occurrence and number of individuals (Beals 1960; Blake 1982). Thus, it is preferable to using either total number of individuals observed or number of segments on which a species was observed to test for differences between control and treatment areas.

Habitat. We used a one-way ANOVA to identify variables that were different between control and treatment transects. Variables were first examined for normality and homoscedasticity of variance prior to statistical analyses (see page 10). We used habitat variables as covariates in ANCOVA and compared adjusted means of abundant species between control and treatment transects. Because not all species respond to all (or to the same) habitat variables, we first performed a multiple regression analysis (step-wise) for each species to select appropriate habitat covariates (maximum of five variables). We found in a previous analysis (Blake et al. ms) that habitat variables selected in regressions were different between years. Therefore, separate regressions were calculated for each species in each year to identify the most appropriate covariates. Covariance analysis was only computed for those species (and years) that met assumptions of this test (e.g., homogeneity of slopes, linearity of response) (Sokal and Rohlf 1981). This included most "abundant" species in each year and month.

Edge effects. We designed our treatment transects to reduce edge effect by not including the ROW and the 25 m adjacent to the ROW in our census belt. It is possible that the effect of the edge penetrates beyond the 25 m we allowed for in our study and if the edge attracts birds we would expect more individuals to be observed on treatment transects than on control transects and to be more abundant on the ROW side of treatment transects. If the edge affects the distribution of forest interior species, we would expect them to be more abundant on control than treatment transects and to be more abundant in the area of treatment transects that is farthest from the antenna. To examine this question, we looked for differences in total number of observations on the right or left side of the transect center line for control transects or between number of observations adjacent to versus opposite the transect center line from the ROW for treatment transects. Observations were classified into 50 m intervals (2 on each side). The distribution in corresponding belts on either side of the transect center line was compared with Fisher's Exact test (Sokal and Rohlf 1981).

In addition, because the previous analyses does not account for differences in habitat between control and treatment areas, we assessed abundance of edge and forest interior species (number of individuals) on transects that were paired based on habitat similarities (see Blake et al. 1989). We examined distribution and abundance of individual species for all years combined in each month separately. Forest interior species examined were: Northern Parula, Ovenbird, Veery, Brown Creeper, Black-and-white Warbler, Canada Warbler, and Red-eyed Vireo. Edge species included: Chestnut-sided Warbler, Common Yellowthroat, Indigo Bunting, Magnolia Warbler, and Song Sparrow (Strelke and Dickson 1980; Blake and Karr 1984; Kroodsma 1984; Small and Hunter 1989).

RESULTS

ELECTROMAGNETIC FIELDS

EM fields associated with the antenna (76 Hz) were an order of magnitude higher on treatment sites than on control sites; 60 Hz exposure was similar in control and treatment areas. Mean 76 Hz longitudinal electric field intensity was 1.3 mV/m (range 0.3 - 2.3 mV/m) on control sites and 157.9 mV/m (range 55 - 566 mV/m) on treatment sites (Appendix 1). Mean 76 Hz magnetic flux density was 0.02 mG on control sites (range 0.007 - 0.04 mG) and 5.2 mG on treatment sites (range 2.1 - 10.2 mG). Transverse 76 Hz electric field was not measurable on control sites and was 0.2 V/m on treatment sites (range 0.1 - 0.4 V/m) (Haradem et al. 1989).

Abundances of seven species were positively correlated with electromagnetic fields on treatment transects, one species was negatively correlated, and two species had both positive and negative correlations (Table 2). It is important to note, however, that the number of significant correlations between bird numbers and EM field magnitudes was not different than what would be expected by chance alone (e.g., 22 and 39 of 624 tests; $P = 0.33$ and $P = 0.27$, respectively, for electric and magnetic fields). Positive or negative correlations within guilds generally resulted from high correlations of single species. For example, abundance of the White-throated Sparrow, a species commonly found in early successional habitat was negatively correlated with electric field magnitudes in September 1988 and 1989. The habitat guild of early successional species also was negatively correlated in the same years and season. Abundance of species that migrate long distances was positively correlated with magnetic field intensities in six cases, but again correlations reflected effects of one or two species (Table 2). Further, correlations were not consistent from one year to the next.

Table 2. Summary by year and month* of species or parameters that were correlated with electric and magnetic field measurements on treatment transects (Pearson correlation). Underlined months indicate negative correlations.

Parameter	Electric Field					Magnetic Field				
	1985	1986	1987	1988	1989	1985	1986	1987	1988	1989
Blue Jay					M					
Black-capped Chickadee		S						$\underline{\text{A}}$		A
Red-breasted Nuthatch								$\underline{\text{Jl}}$	A	
Hermit Thrush									Ju	Jl
Red-eyed Vireo										Jl
Nashville Warbler				Jl						
Chestnut-sided Warbler							M			
Black-throated Green Warbler				Ju				M	Ju	
Ovenbird							M	A	Jl	
White-throated Sparrow				$\underline{\text{S}}$	$\underline{\text{S}}$		$\underline{\text{Ju}}$			
Individuals										A
Species							Ju	$\underline{\text{A}}$		
Long-distance Migrants						Ju	M		JuJlS	A
Short-distance Migrants										S
Permanent Residents		S								A
Ground Inverts and seeds				S	S		M			
Ground Inverts and fruit					Ju					
Foliage Insects and fruit					$\underline{\text{Jl}}$					
Flycatcher						Ju			S	
Canopy Nest			S	$\underline{\text{Jl}}$			MJu		Ju	A
Cavity Nest		S						M		
Ground Nest			A	$\underline{\text{S}}$						
Deciduous			S				M	Jl		A
Coniferous			S				Ju		Jl	
Mixed									Ju	
Lowland Conifer					$\underline{\text{Jl}}$					
Early Successional				$\underline{\text{S}}$	$\underline{\text{S}}$					
Fields and meadows					A					

* M - May; Ju - June; Jl - July; A - August; S - September

HABITAT

Vegetation differed between control and treatment areas in several respects (Table 3). Of greatest probable influence on birds was the pronounced difference in dominance of coniferous and deciduous trees. Control transects had more deciduous trees (aspen, yellow birch, red maple, sugar maple) and treatment transects were dominated by coniferous (black spruce, balsam fir) tree species (Table 3).

COMMUNITY PARAMETERS

Numbers of individuals and species observed on control and treatment areas remained similar throughout the study. A total of 38,934 birds were observed during the study period: 19,647 on treatment segments and 19,287 on control segments. We recorded a total of 125 species over the five-year period. Of the total, 11 species were recorded only on control and 12 species only on treatment segments (Appendix 4).

Bird abundance was highest during May and June, declined through the summer (July, August), and then increased slightly in fall (Figure 3). Numbers of species and individuals varied annually in each month except number of species in July (Table 4). A significant interaction was found in the two-way ANOVA for number of individuals in June; total abundance was higher on treatments in 1985 and 1986, but higher on controls during 1987 and 1989.

Two significant treatment effects (2-way ANOVA) were detected in the community parameter data. Both indicated that more species were observed on treatment relative to control areas in June and July (Table 4). Effects were not pronounced; differences between treatment and control for each year separately were significant only in 1985.

Table 3. Means and coefficients of variation (CV) per segment of vegetation variables used in covariance analysis. Differences between control and treatment segments (one-way ANOVA) are indicated. "+" = value < 0.5 but > 0.0. Tree importance values are sums of relative frequency, relative dominance, and relative cover.

Habitat variable	Control (N=40) Mean	Control (N=40) CV%		Treatment (N=40) Mean	Treatment (N=40) CV%
Canopy cover (%)	19	83.0	*	26	65.7
Water depth (cm)	1	265.7		+	287.4
Ground cover (%)	29	69.8		31	66.3
Number of tree species	10	24.4		9	25.4
Number of shrub species	13	22.1		12	19.2
Shrub density/m^2	66	40.9		69	65.1
Tree density/.01 ha	17	49.4		21	41.0
Log density/.01 ha	105	100.7		79	76.3
Tree height (m)	10	27.6		9	31.1
Shrub height (dm)	10	24.3	*	11	22.9
Total coniferous basal area cm^2/.01 ha	986	84.1	***	2529	82.9
Total deciduous basal area cm^2/.01 ha	2101	48.7	*	2115	199.9
Density trees 2-7.5 cm dbh/.01 ha	6	76.4		8	85.3
Density trees 7.6-15 cm dbh/.01 ha	5	76.0		7	77.5
Density trees 15.1-23 cm dbh/.01 ha	2	49.8		4	138.0
Density trees > 23 cm dbh/.01 ha	4	54.7		5	88.7
Tree importance values					
Aspen (Populus species)	35	124.5	*	54	94.3
Paper Birch (Betula papyrifera)	15	143.6		19	126.0
Yellow Birch (B. alleghaniensis)	26	108.9	***	9	218.0
Red Maple (Acer rubrum)	60	77.5	***	25	104.7
Sugar Maple (A. saccharum)	64	107.8	***	19	173.3
Black Ash (Fraxinus nigra)	40	132.5	***	17	230.5
Balsam Fir (Abies balsamea)	67	78.4		84	64.6
Black Spruce (Picea mariana)	16	207.8	***	34	123.4
Northern White Cedar (Thuja occidentalis)	17	153.9		14	192.5

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

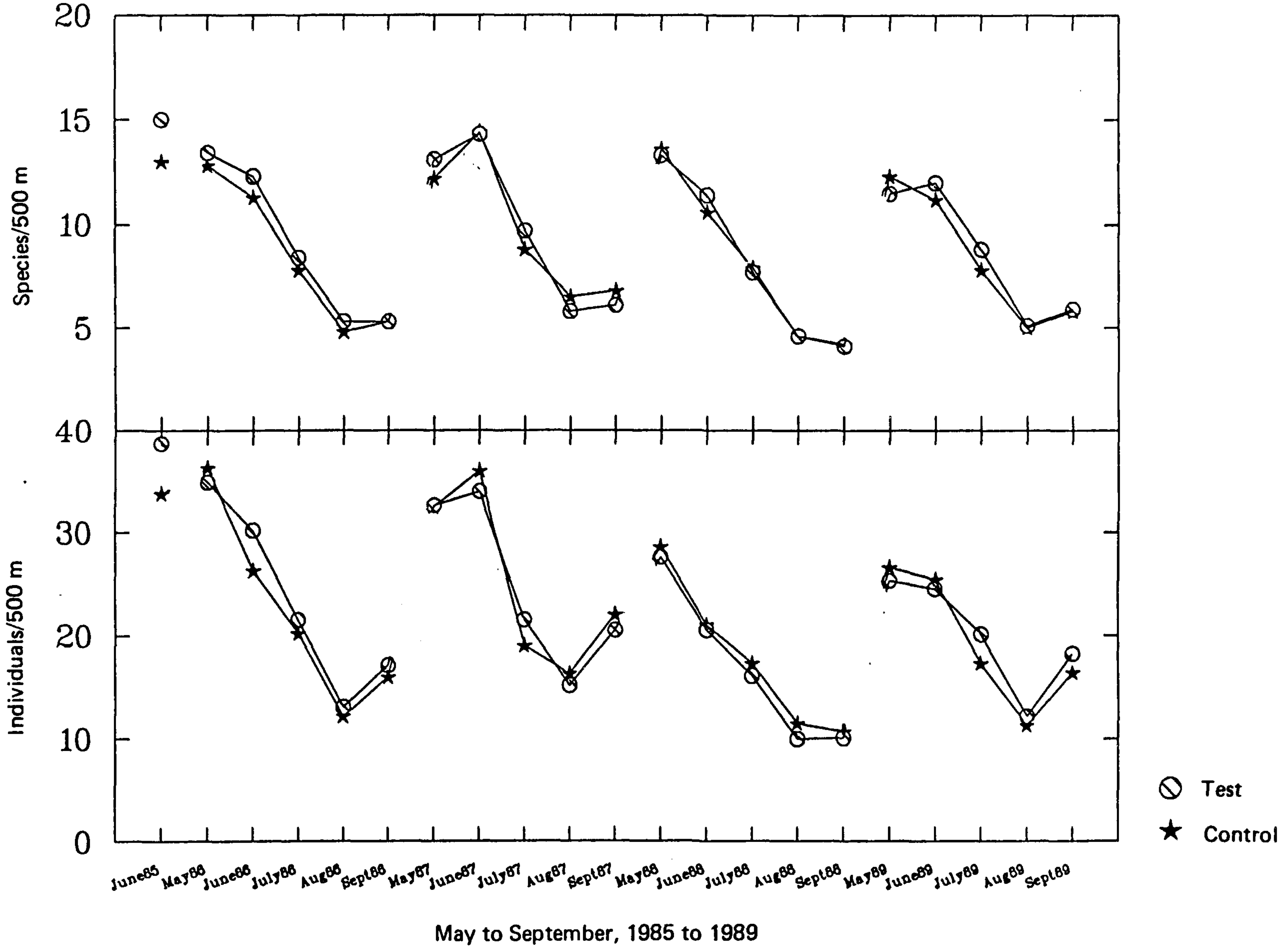

Figure 3. Abundance of species and individuals (500 m) on control (control) and treatment (test) transects throughout the study period.

Table 4. Mean observations in a 500m segment on control (C) and treatment (T) segments, 1985-89; significance of one-way ANOVAs between treatment and control segments is shown for each year. For two-way ANOVAs, T=treatment effect, Y=year effect, and I=interaction. Two-way ANOVAs were calculated with logged segments excluded.

Month	1985		1986		1987		1988		1989		ANOVA		
	T	C	T	C	T	C	T	C	T	C	T	Y	I
May:													
indiv.			34.9	36.3	32.6	32.5	27.6	28.6	25.3	26.6		***	
species			13.4	12.8	13.1	12.2	13.3	13.6	11.5	12.3		*	
June:													
indiv.	38.7**	33.8	30.2 *	26.3	34.0	36.0	20.5	21.0	24.5	25.4		***	*
species	15.0 *	13.0	12.3	11.3	14.3	14.4	11.4	10.6	12.0	11.2	*	***	
July:													
indiv.			21.5	20.2	21.5	19.0	16.1	17.3	20.1	17.3		**	
species			8.4	7.8	9.7	8.8	7.7	7.9	8.8	7.8	*		
August:													
indiv.			13.1	12.2	15.2	16.3	10.0	11.5	12.2	11.3		***	
species			5.3	4.8	5.8	6.5	4.6	4.6	5.1	5.0		**	
September:													
indiv.			17.1	16.0	20.5	22.0	10.1	10.7	18.2	16.4		***	
species			5.3	5.3	6.1	6.8	4.1	4.2	5.9	5.8		***	

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

INDIVIDUAL SPECIES

Overall (after ANCOVA), we detected differences in abundance for 38 individual species between control and treatment transects over five years and five seasons (Table 5). Nineteen species were more abundant in control areas, 16 more abundant in treatment areas, and three species were not consistently more abundant in either control or treatment areas (Table 5). The number of species that differed in abundance between control and treatment areas was independent of month (χ^2 = 1.9; P = 0.5) and year (χ^2 = 1.7; P = 0.8). In addition, number of species that were consistently more abundant (at least two differences) on treatment (eight) or control (six) were also independent of month (χ^2 = 1.9; P = 0.6) and year (χ^2 = 6.0; P = 0.1).

Only six of the 38 species that differed in abundance between control and treatment segments were abundant (see methods) species. We were able to adjust abundant bird species numbers on control and treatment transects by using habitat variables as covariates in ANCOVA. As expected, this analysis was most useful when applied to May and June data when bird numbers were most correlated with habitat structure. Following ANCOVA, 62% of adjusted P-values were lower than unadjusted values, 24% were higher, and 14% did not change (Table 6). This analysis was successful in explaining the consistent trend of more (significant ANOVA) Chestnut-sided Warblers on treatment transects; in four of five cases adjusted means did not differ between treatment and control transects (Table 6). In addition, adjusted means for the Ovenbird which was consistently more abundant on control transects did not show a treatment effect in five of six cases (Table 6). In contrast, adjusted means for the Black-throated Green Warbler indicated that this species was significantly more abundant on control transects (two of three tests in May); unadjusted means showed the opposite pattern (Table 6). The ANCOVA was not successful in adjusting means

Table 5. Summary by year and month* of species that were significantly more abundant on treatment or control segments. Underlined months indicate that differences were tested by ANOVA (i.e., "abundant" species; see text). Differences for common species (not underlined) were based on goodness-of-fit G-tests. Forest interior[1] and edge[2] species used in paired tests (see text and Figure 5) are identified.

Species	More abundant on treatment					More abundant on control				
	1985	1986	1987	1988	1989	1985	1986	1987	1988	1989
Alder Flycatcher	Ju									
Red-breasted Nuthatch			JyA	Ju	S					
Golden-crowned Kinglet		Ju			MJuS					
Nashville Warbler		A			S					
Chestnut-sided Warbler[2]			M	Jy	Jy					
Magnolia Warbler[2]		M	M							
Cape May Warbler		M								
Yellow-rumped Warbler	Ju				Ju					
Mourning Warbler					Ju					
Common Yellowthroat[2]	Ju	M			M					
Indigo Bunting[2]		Ju			JuJy					
Chipping Sparrow	Ju	Ju	Ju	MJu	MJu					
Song Sparrow[2]		M		Ju						
Swamp Sparrow	Ju	Ju	Jy		Jy					
White-winged Crossbill			Jy							
Evening Grosbeak	Ju									
Ruby-crowned Kinglet				S				A		
Hermit Thrush		JyA						Ju	Ju	
American Robin	Ju							Ju		
Ruffed Grouse						Ju	S		S	
Yellow-bellied Sapsucker										M
Downy Woodpecker										A
Eastern Wood-Pewee								Ju	Ju	
Great Crested Flycatcher						Ju	Ju	M		
Blue Jay							Jy		Jy	A
Brown Creeper[1]									A	
Winter Wren						Ju		Jy		M
Veery[1]							Ju			
Cedar Waxwing									A	Ju
Red-eyed Vireo[1]								A	Ju	
Northern Parula[1]							M			
Black-throated Green Warbler								M		M
Blackburnian Warbler									Ju	
Black-and-white Warbler[1]							M			
Ovenbird[1]										MJu
Canada Warbler[1]							Ju	M		
Rose-breasted Grosbeak							MJu	M		
Brown-headed Cowbird										M

* M - May; Ju - June; Jy - July; A - August; S - September.

[1]Forest interior species

[2]Edge species

Table 6. Unadjusted (ANOVA) and adjusted (ANCOVA) P-values for species by year and month. Habitat variables selected by multiple regression were used as covariates in ANCOVA to derive adjusted mean values for control and treatment segments.

Species	Year	Month	Unadjusted P-value	Adjusted P-value	More Abundant
Least Flycatcher	1987	May	0.006	0.31	C
	1988	June	0.03	0.65	C
Yellow-bellied Flycatcher	1985	June	0.009	0.17	C
Blue Jay	1987	May	0.01	0.06	T
Black-capped Chickadee	1989	July	0.02	0.12	C
Red-breasted Nuthatch	1987	Aug	0.008	0.02	C
	1989	Sept	0.38	0.02	T
Winter Wren	1985	June	0.002	0.002	C
Hermit Thrush	1987	June	0.36	0.03	T
	1986	July	0.20	0.01	T
Red-eyed Vireo	1988	June	0.92	0.02	C
	1989	June	0.03	0.75	C
Nashville Warbler	1986	June	0.01	0.06	T
	1989	July	0.01	0.10	T
Northern Parula	1986	May	0.001	0.02	C
Chestnut-sided Warbler	1987	May	0.57	0.03	T
	1988	May	0.03	0.14	T
	1985	June	0.003	0.06	T
	1987	June	0.03	0.29	T
	1988	June	0.03	0.24	T
Yellow-rumped Warbler	1986	Sept	0.04	0.10	T
Black-throated Green Warbler	1987	May	0.55	0.04	C
	1988	May	0.79	0.05	C
	1989	May	0.01	0.64	C
Black-and-white Warbler	1986	May	0.003	0.006	C
	1989	May	0.02	0.08	C
Ovenbird	1986	May	0.004	0.13	C
	1987	May	0.004	0.69	C
	1989	May	0.003	0.39	C
	1987	June	0.001	0.06	C
	1988	June	0.02	0.89	C
	1989	June	0.001	0.001	C
Common Yellowthroat	1989	May	0.06	0.02	T
White-throated Sparrow	1986	Sept	0.01	0.10	C

C = control
T = treatment

with habitat variables for three species; Winter Wren, Northern Parula, and Common Yellowthroat.

EDGE EFFECTS

Two species, the Indigo Bunting (June) and Red-eyed Vireo (May) were significantly more abundant on the antenna side of treatment transects (Figure 4). The Northern Parula showed the opposite pattern in June (Figure 4). Distribution of Chestnut-sided Warblers (June) was also significantly different, but no clear attraction to the ROW edge was evident for this species; numbers of individuals observed on either side of the transect were almost identical (e.g., 204 and 206 individuals) (Figure 4).

Although the distribution of most edge or interior forest species did not appear to be affected by the ROW (within 225 m), five species associated with edges were more abundant on treatment transects (Chestnut-sided Warbler, Magnolia Warbler, Common Yellowthroat, Indigo Bunting, Song Sparrow) and seven species that prefer forest interior were more abundant on control transects (Red-eyed Vireo, Black-and-white Warbler, Ovenbird, Veery, Brown Creeper, Northern Parula, Canada Warbler) (Table 5). Some differences in edge and forest interior species abundances between control and treatment areas could be explained by habitat (see ANCOVA above). However, in some months and for some species the ANCOVA was not successful in adjusting means based on habitat (Table 6). In addition, analyses of transects paired by habitat similarity indicated that abundance of edge individuals was higher on treatment transects in May (3 of 4 years), June (3 of 5 years), and July (2 of 4 years) (Figure 5). Abundance of forest interior individuals showed the opposite pattern;

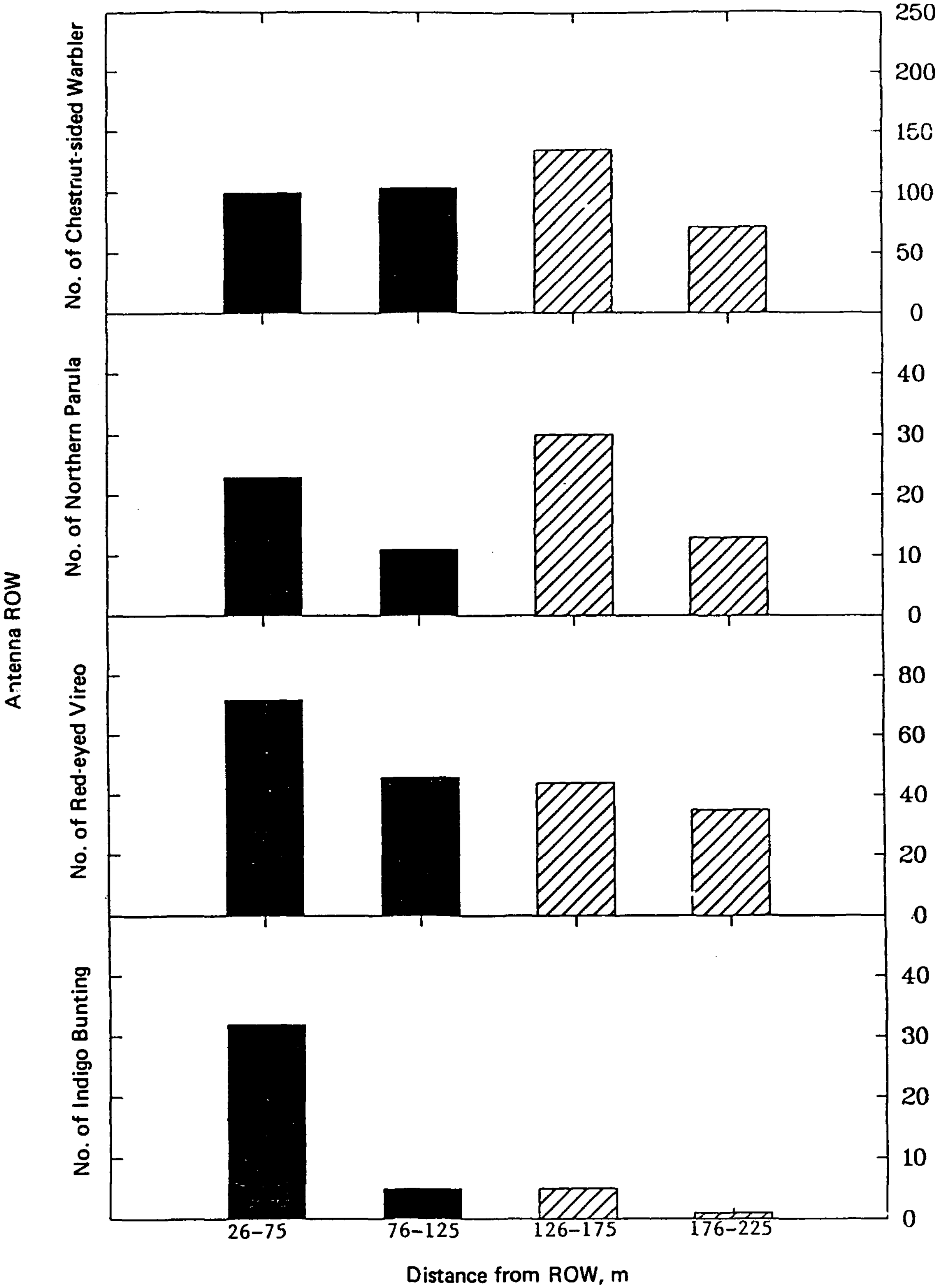

Figure 4. Distribution of four species in relationship to the antenna ROW.

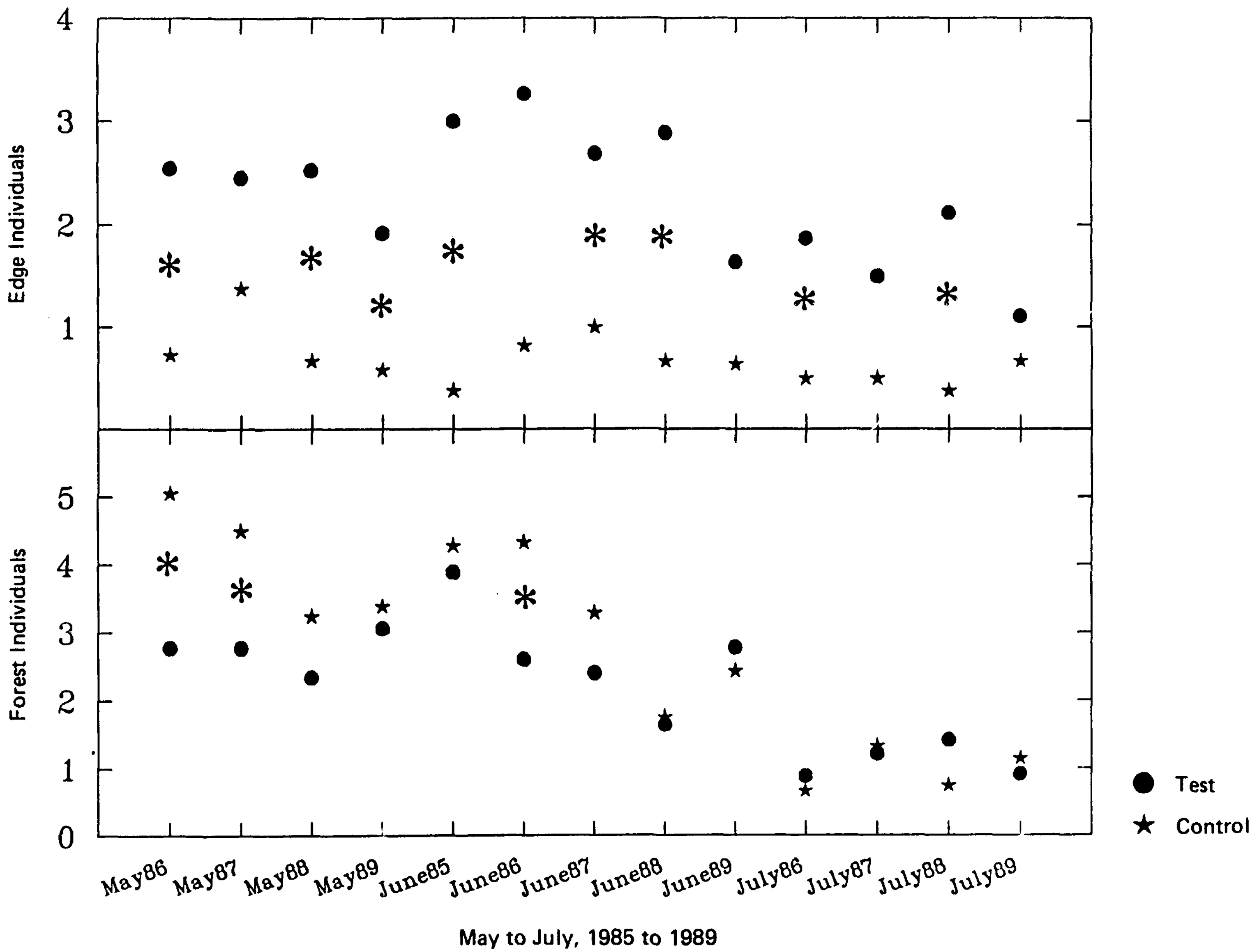

Figure 5. Number of edge and forest bird species individuals on paired transects. Asterisks indicate significant differences ($P < 0.05$) between control (control) and treatment (test) based on paired t-tests. Transects were paired based on habitat similarities.

control areas had more forest interior species, but only significantly so in May (2 of 4 years) and June (1 of 5 years) (Figure 5).

BIRD GUILDS

More birds associated with deciduous forest were observed on control than on treatment transects in all months; the reverse was true for birds associated with coniferous forest (Table 7). Differences in other habitat guilds were less pronounced. Annual variation in abundance within guilds reflected the same pattern of annual variation that we saw in total bird numbers (Figure 3, Table 4). The lack of significant interaction terms for any habitat category in any month indicates that relative abundance of birds within guild categories remained consistent on treatment and control transects over the four to five year period.

We detected fewer differences in abundance between control and treatment areas in foraging guild categories than in habitat guilds; all differences were found in May, June, and July (Table 8). Differences were most pronounced for birds feeding on invertebrates and seeds on the ground (Table 8). Annual variation in abundance within foraging guilds was more pronounced, particularly for foliage and bark insectivores. Again, the lack of significant interaction terms within these categories indicates that numbers of individuals on both control and treatment areas were responding to similar factors.

Table 7. Mean observations (500 m) on control (C) and treatment (T) segments, 1985-89 for habitat guilds that showed significant treatment (T) or year (Y) effects by month.

Parameter	1985		1986		1987		1988		1989		2-way ANOVA		
Month	T	C	T	C	T	C	T	C	T	C	T	Y	I
Deciduous Forest													
May			10.3	12.9	9.1	12.1	8.9	10.5	8.1	10.5	***		
June	15.2	15.8	9.8	11.5	9.1	12.1	6.3	7.9	8.3	10.2	**	***	
July			6.3	7.8	5.6	7.1	4.6	6.9	6.0	6.5	**		
August			4.8	5.9	4.5	6.1	4.2	5.5	4.5	5.1	*		
September			4.7	5.4	5.8	7.8	3.8	5.4	5.5	7.0	**	*	
Coniferous Forest													
May			2.7	1.8	2.4	1.9	2.5	2.2	2.6	1.4	**	**	
June	2.8	1.4	2.6	1.2	2.4	2.2	1.6	1.1	1.9	1.1	***		
July			2.4	1.1	3.3	1.8	1.4	1.4	1.7	1.1	**	*	
August			2.7	2.0	4.4	3.8	1.7	1.0	1.3	1.3		***	
September			7.8	5.1	7.5	8.1	2.4	1.2	7.7	5.5	**	***	
Mixed Con-Dec Forest													
May			11.3	12.7	9.4	9.8	6.5	7.0	6.2	7.7	*	***	
June	9.9	9.5	7.3	6.4	8.9	9.2	4.0	5.2	5.8	6.9		***	
July			3.7	3.5	3.8	3.5	3.8	3.9	5.3	4.7		**	
September			0.5	0.6	0.9	0.9	0.5	0.5	1.1	1.1		**	
Early Successional Forest													
May			5.0	4.1	6.6	4.4	4.1	3.3	4.1	3.5	*	*	
June	4.8	3.1	5.1	3.9	6.5	5.6	4.1	3.0	4.4	3.5	**	**	
August			0.8	1.2	1.6	1.8	0.4	1.2	1.8	1.0		*	
Fields & Meadows													
May			1.8	1.3	1.1	1.5	1.9	1.4	0.7	1.1		**	
June	1.8	0.7	1.4	1.0	1.6	1.8	1.4	0.9	1.1	1.2	*		

* P < 0.05; ** P < 0.01; ***P < 0.001

Table 8. Mean observations (500 m) on control (C) and treatment (T) segments, 1985-89 for foraging guilds that showed significant treatment (T) or year (Y) effects by month.

Parameter	1985		1986		1987		1988		1989		2-way ANOVA		
Month	T	C	T	C	T	C	T	C	T	C	T	Y	I
Ground invertebrates & fruit													
May			7.0	8.3	5.9	7.4	5.2	5.7	5.1	6.1	*	*	
June	9.1	7.7	6.1	6.3	5.5	7.5	3.2	4.5	5.1	6.2		***	
September			1.6	0.8	1.2	1.3	0.5	0.6	1.3	1.8		**	
Ground invertebrates & seeds													
May			3.9	2.8	4.9	3.4	3.0	2.3	3.0	2.3	*	*	
June	2.7	1.3	4.5	2.6	4.9	4.0	2.7	1.6	2.3	1.8	***	***	
July			3.2	3.5	2.2	2.0	2.2	1.8	2.7	1.4	*		
August			0.9	1.2	0.8	0.4	0.3	0.3	0.8	0.3		*	
September			1.6	2.0	3.1	2.2	0.9	1.1	1.1	0.8		*	
Foliage insects and fruit													
May			18.2	18.2	16.0	15.6	12.7	12.3	12.0	11.7		***	
June	20.1	16.9	14.2	12.4	15.9	15.6	9.5	9.3	11.7	11.9		***	
July			9.8	8.2	7.8	7.8	7.0	7.4	9.7	7.5		*	
August			5.5	5.4	6.4	5.7	3.7	3.5	5.4	4.8		***	
September			10.1	7.3	6.9	8.0	5.0	4.0	6.2	3.9		***	
Flycatchers													
May			0.8	1.6	0.7	1.8	0.9	1.6	1.0	1.5		***	
June	3.0	4.8	1.7	2.0	1.9	2.9	1.4	1.9	2.0	1.9	***	***	
Bark insects													
May			1.3	2.2	1.3	1.8	2.3	2.6	1.5	1.9	***	**	
June	1.5	1.7	1.1	1.1	1.8	1.9	1.5	1.2	1.3	1.5		*	
July			1.1	0.8	1.6	1.4	1.0	1.3	0.7	0.7		**	
August			1.1	1.4	2.1	2.8	1.3	1.8	1.3	1.5		***	
September			2.1	2.2	4.8	5.8	0.7	0.9	5.7	6.0		***	

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

DISCUSSION

BIRD COMMUNITY ABUNDANCE PATTERNS

We found no convincing evidence that bird distribution patterns or abundance of birds were affected by EM fields produced by the ELF antenna in Wisconsin. Significantly more species were observed on treatment segments in June and July, but differences were not pronounced (mean difference usually < one species). It is important to note that, because of the power of our statistical tests for community parameters, a difference of one species between control and treatment areas indicated a statistically significant difference. Possible biological explanations for this observed statistical difference in number of species could be related to the proximity of the treatment areas to the ROW or habitat differences. Although our treatment transects were placed such that birds adjacent to and along the ROW were not counted, it is possible that effects of the ROW penetrated further into adjacent areas than the 25 m that we allowed for (Hansson 1983). Edge bird communities typically have higher species richness (Robinson 1988).

Bird communities (number of species, number of individuals) varied substantially during this study (see Blake et al. 1990). Overall, abundance declined from 1985 to 1988 and then rebounded slightly in 1989. Declines were probably related to weather; a severe drought occurred in 1988, following two relatively dry years (1986-1987). Annual variation in bird abundances also may reflect timing of sampling in relation to migration phenology. Weather during migration may profoundly influence abundance of birds in a particular area (Richardson 1978). Thus, differences in weather from one year to the next may produce apparent (as well as real) differences in bird abundance. If arrival of most migrants was later in one year than in another, we might record substantial variation in abundance between years. We attempted to minimize this by sampling at approximately the same period (calendar date) each year. Patterns of annual variation,however, were similar on

treatments and controls, indicating that birds responded primarily to environmental conditions and not to EM fields produced by the antenna (see Rogers 1981).

GUILD DISTRIBUTION PATTERNS

It is useful to analyze bird distribution patterns within guilds for several reasons (see Verner 1984). First, species that belong to the same guild share common biological characteristics. Thus, if the ELF antenna system influences abundance of bird species we might expect members of a particular guild to be influenced in a similar fashion. Second, uncommon species that are not present in numbers sufficient for statistical analyses (e.g., ANOVA) are included in guild analyses. Thirdly, because mean values within guild categories are generally higher and CVs lower than those for individual species, guild analyses are more powerful statistically (e.g, smaller differences can be detected). Moreover, differences in bird abundance between control and treatment areas that are related to habitat may be evident from the distribution pattern of guild members.

Differences between control and treatment areas in abundance of different guilds defined on the basis of preferred breeding habitat clearly reflected differences in habitat structure between control and treatment areas. Control transects had more deciduous trees and more birds that prefer deciduous habitats occurred in control than in treatment areas in all months. The reverse was true for birds preferring coniferous habitat. In addition, due to recent logging along the antenna, birds associated with early-successional habitat were more abundant in treatment than in control areas in May and June. These results suggest that differences in bird abundance between control and treatment areas were primarily related to differences in deciduous-coniferous habitats in these areas.

ABUNDANCE OF INDIVIDUAL SPECIES

Habitat or EM related differences that exist between control and treatment areas may not influence all bird species in the same manner. If some species are more abundant on control and others on treatment segments, then such differences might cancel each other, producing nonsignificant results at the community level. If differences between treatment and control segments (either related to habitat or EM fields) are primary factors influencing distribution patterns of individual species, then we might expect those species to show similar patterns among years and seasons.

There were relatively few cases where differences in abundance of a species between control and treatment have remained consistently significant among seasons and years. Nineteen species were more abundant on control segments; ten were more abundant in more than one season or year. More consistent differences were found for those species that were more abundant on treatment transects; 11 of 16 were found to be more abundant on treatment segments in more than one season or year. Three species have been more abundant in control areas in one season and treatment areas in another. For example, the Hermit Thrush was more abundant on treatment transects in July and August 1986, but more common on control segments in June 1987 and 1988. Such variations may reflect seasonal changes in habitat selection. For example, a species may breed in one habitat but then move into a different habitat following breeding. If distribution of breeding and nonbreeding habitats differ between treatments and controls, a switch in abundance between treatments and controls also may occur.

Results of this and many previous studies indicate that birds select breeding areas (and, to a lesser extent, migration stop-over points) largely on the basis of vegetation structure (e.g., Lack 1933; Hilden 1965; James 1971; Cody 1985). Areas with similar vegetation typically support similar bird communities. In addition, we have demonstrated

that differences in bird abundance between control and treatment areas could be explained on the basis of habitat differences.

Pre-impact data on bird populations were not available for this area so we could not assume that the antenna system had not already affected bird distribution patterns in the area. Consequently, we could not compare transect segments based solely on similarities in bird species communities. However, by incorporating measured habitat variables into the analyses (i.e., through ANCOVA) we were able to adjust bird species abundance in control and treatment segments to account for habitat effects. This analysis was especially useful for May and June data when bird numbers were most correlated with habitat structure. For example, the apparent preference of Chestnut-sided Warblers (June) for treatment areas was no longer observed after effects of habitat were accounted for. A similar result was seen for the Ovenbird. Overall, the ANCOVA has provided furthur evidence that differences in many bird species abundance between control and treatment segments were due to habitat structure and were likely not related to EM fields.

ROW AND EDGE

Bird community composition is not only affected by habitat structure, but also by the heterogeneity and spatial arrangement of habitats. Clearing of ROWs (and logging) increases the amount of edge in the landscape; potentially changing bird species composition, biomass, and richness (Robinson 1988). Previous studies that have assessed effects of powerlines on bird communities have found that new communities are created after ROWs are cut; most changes were due to habitat alteration or edge associated with the ROW. None have attributed changes to EM fields associated with power distribution lines (see introduction for references).

We positioned our study areas to minimize potential effects of the ROW and edge, but still insure relatively high EM exposure; birds in the ROW and 25 m adjacent to the ROW were not counted. However, effects of the ROW clearing and edge associated with it may extend furthur into adjacent areas than the 25 m that we allowed for. For example, distribution of three species appeared to be directly affected by the ROW. A species associated with edges, the Indigo Bunting (Strelke and Dickson 1980; Small and Hunter 1989) was more abundant (in June) on treatment transects and more abundant on the antenna side of treatment transects. Abundance (June) of the Northern Parula, a species associated with forest interiors (Small and Hunter 1989) was more abundant on control transects and more abundant on the side of treatment transects farthest away from the antenna. Another species associated with the forest interior during the breeding season, the Red-eyed Vireo (Strelke and Dickson 1980; Kroodsma 1984), although more abundant on control transects, showed an attraction to the ROW on treatment transects in May. This, however, may be a spurious result due to the large number of tests completed.

Although we found no indication that other species (forest interior or edge) distributions along the antenna were directly affected by the edge, results suggest that bird community composition along the antenna may have been affected by clearing the ROW. Numbers and abundances of species associated with forest edges were higher in treatment areas; five of 16 species more common on treatment transects were edge species. Seven of 19 species more abundant on control transects were species associated with forest interiors (see Table 5). Differences in abundance of forest and edge species were probably not related to habitat differences between control and treatment areas. Paired tests showed a consistent pattern (8 of 13 tests) that edge individuals were more abundant in treatment areas (May, June, and July). However,

numbers of forest interior individuals were not always significantly lower in treatment areas (3 of 13 tests). Because we have no data on bird community structure prior to ROW construction, we can not be absolutely certain that differences that exist between control and treatment areas were due to ROW construction. Differences in forest management practices between control and treatment areas (e.g., size of continuous habitat stands (Blake and Karr 1984)) could have a similar effect on bird community composition. Comparisons of edge and forest interior species distributions may be more relevant in Michigan because we can examine bird community changes in subsequent years after the ROW was constructed.

We found no evidence to suggest that the ROW clearing affected nest predation and parasitism in treatment areas (Gates and Gysel 1978; Reese and Ratti 1988; Yahner and Scott 1988). Brown-headed Cowbirds (a nest parasite) were not common in the study areas and were actually more abundant in control areas. This suggests that nest parasitism was not a negative factor of the ROW clearing in this study. If nest predation was higher along the ROW, we may have expected to see a decrease in bird recruitment in following months (e.g., July and August individuals) along treatment transects. Although no such pattern was observed, we cannot exclude the possibility that birds immigrated into treatment areas from other areas during the post-breeding season.

EM FIELDS

Growth or navigational abilities of birds exposed to the ELF antenna could be affected by EM fields and are being studied in Michigan with Tree Swallows (Beaver et al. 1988), but we will address possible effects on migration. Many birds use the earth's EM field as an aid in navigation during migration. Larkin and Sutherland (1979) observed that birds flying over the antenna (in Wisconsin) changed course more often than control

individuals. Similarly, weak EM fields can cause disorientation in homing pigeons (Wiltschko and Wiltschko 1988). However, although individuals in homing experiments were momentarily disoriented, all were able to adjust to EM field anomalies and successfully navigate. We detected no consistent differences in bird abundance between control and treatment segments during migration (May, August, September), suggesting that birds were not attracted to or repelled by the antenna. Although the statistical power of our tests is lower during migration, if the antenna affected migrating birds, we would have expected to see some pattern of differences in the large number of parameters we measured (e.g., difference in migratory guilds).

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LITERATURE CITED

American Ornithologists' Union. 1983. Check-list of North American birds. Sixth Edition. American Ornithologists' Union, Washington, D.C.

________________________. 1985. Thirty-fifth supplement to the American Ornithologists' Union check-list of North American birds. Auk 102: 680-686.

Anderson, S.H. 1979. Changes in forest bird species composition caused by transmission-line corridor cuts. Amer. Birds 33: 3-6.

____________, K. Mann, and H.H. Shugart, Jr. 1977. The effect of transmission-line corridors on bird populations. Amer. Midl. Natur. 97: 216-221.

Beals, E. 1960. Forest bird communities in the Apostle Islands of Wisconsin. Wilson Bull. 72: 156-181.

Beaulaurier, D.L., B.W. James, P.A. Jackson, J.R. Meyer and J.M. Lee. 1982. Mitigating the incidence of bird collisions with transmission lines. Third Symp. on Env. Concerns in ROW Management, San Diego, CA.

Beaver, D.L., J.H. Asher, and R.W. Hill. 1988. Small vertebrates: Small mammals and nesting birds. In, Compilation of 1987 Annual Reports of the Navy ELF Communications System Ecological Monitoring Program, Technical Report E06595-2.

Bell, H.L. 1980. The effects of a powerline clearing on birds of dry sclerophyll forest at Black Mountain Reserve, Australian Capital Territory. Corella 4: 8-19.

Bent, A.C. 1963. Life histories of North American wood warblers. Dover Publications, New York, NY.

________. 1964. Life histories of North American thrushes, kinglets, and their allies. Dover Publications, New York, NY.

Blake, J.G. 1982. Influence of fire and logging on nonbreeding bird communities of ponderosa pine forests. J. Wildl. Manage. 46: 404-415.

_________ and J.R. Karr. 1984. Species composition of bird communities and the conservation benefit of large versus small forests. Biol. Conserv. 30: 173-187.

_________, J.M. Hanowski, and G.J. Niemi. 1989. ELF communications system ecological monitoring program: bird species and communities. Annual Report 1988, Subcontract No. E06549-84-011. In Compilation of 1988 Annual Reports of the Navy ELF Communications System Ecological Monitoring Program, July 1989; Technical Report E06595-6, Contract No. N00039-88-C-0065. pp. 98.

_________________________. Correlations between birds and habitat: annual variation in species-habitat relationships. Submitted to Condor.

_________, G.J. Niemi, and J.M. Hanowski. 1990. Drought and annual variation in bird populations: effects of migratory strategy and breeding habitat. (in review, symposium on neotropical migrants, Manomet Observatory).

Bramble, W.C., W.R. Byrnes and M.D. Schuler. 1984. The bird population of a transmission right-of-way maintained by herbicides. J. Arboriculture 10: 13-20.

Brosh, R.M., J.R. Gauger, and J.E. Zapotosky. 1986. ELF communications system ecological monitoring program: electromagnetic field measurements and engineering support-1985. IIT Research Institute Tech. Rpt. EO6549-24 Chicago, IL.

Buckland, S.T. 1985. Perpendicular distance models for line transect sampling. Biometrics 42: 177-195.

Burnham, K.P., D.R. Anderson, and J.L. Laake. 1981. Line transect estimation of bird population density using a fourier series. Studies in Avian Biol. No. 6: 466-482.

Chasko, G.G. and J.E. Gates. 1982. Avian suitability along a transmission-line corridor in an oak-hickory forest region. Wildl. Monogr. 82: 1-41.

Cody, M.L. ed. 1985. Habitat selection in birds. Academic Press, Inc., Orlando, FL.

Cottam, G. and J.T. Curtis. 1956. The use of distance measurements in phytosociological sampling. Ecology 37: 451-460.

Dawson, B.A. and J.E. Gates. 1979. Habitat-niche discrimination of passerines along a transmission-line corridor. 2nd Symp. on Env. Concerns in Rights-of-Way Management, Univ. of Mich., Ann Arbor, MI.

Emlen, J.T. 1971. Population densities of birds derived from transect counts. Auk 88: 323-342.

_________. 1977. Estimating breeding season bird densities from transect counts. Auk 94: 455-468.

Gates, C.E. 1981. Optimizing sampling frequency and number of transects and stations. Stud. Avian Biol. 6: 399-404.

_________ and L.W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. Ecology 59: 871-883.

Green, J.C. and G.J. Niemi. 1978. Birds of the Superior National Forest. Publ. of U.S. Dept. Agric. Forest Service. 82 pp.

Hanowski, J.M. and G.J. Niemi. 1986. ELF communications system ecological monitoring program: bird species and communities. Annual Report 1985, Subcontract No. EO6549-84-011. In Compilation of 1985 Annual Reports of the Navy ELF Communications System Ecological Monitoring Program, July, 1986; Technical Report EO6549-26, Contract No. N00039-84-C-0070. pp 94.

__________________________ and J.G. Blake. 1987. ELF communications system ecological monitoring program: bird species and communities. Annual Report 1986, Subcontract No. EO6549-84-011. In Compilation of 1986 Annual Reports of the Navy's ELF Communications System Ecological Monitoring Program, July, 1987; Technical Report EO6549-38, Contract No. N00039-84-C-0070.

____________________________________. 1990. Statistical perspectives and experimental design when counting birds on line transects. Condor 92: 328-337.

Hansson, L. 1983. Bird numbers across edges between mature conifer forest and clearcuts in Central Sweden. Ornis. Scand. 14: 97-103.

Haradem, D.P., J.R. Gauger, and J.E. Zaptosky. 1989. ELF communications system ecological monitoring program: electromagnetic measurements and engineering support - 1988. IITRI Technical Report E06595-5 to Space and Naval Warfare Systems Command, Washington, D.C.

Hilden, O. 1965. Habitat selection in birds. Ann. Zoo. Fennici 2: 53-75.

James, F.C. 1971. Ordinations of habitat relationships among breeding birds. Wilson Bull. 83: 215-236.

Järvinen, O. and R. Väisänen. 1975. Estimating the relative densities of breeding birds by the line transect method. Oikos 26: 316-322.

Kroodsma, R.L. 1982. Edge effect on breeding birds along a power-line corridor. J. Appl. Ecology 19: 361-370.

____________. 1984. Ecological factors associated with degree of edge effect in breeding birds. J. Wildl. Manage. 48: 418-425.

Lack, D. 1933. Habitat selection in birds: with special reference to the effects of afforestation on the Breckland Avifauna. J. Anim. Ecol. 2: 239-262.

Larkin, R.R. and P.J. Sutherland. 1979. Migrating birds respond to project Seafarer's electromagnetic field. Science 195: 777-779.

Lee, J.M., Jr., T.D. Bracken, and L.E. Rogers. 1979. Electric and magnetic fields as considerations in environmental studies of transmission line, pp. 55-73. In Biological effects of extremely low frequency electromagnetic fields. Conf-78106. National Tech. Inf. Serv. Springfield, VA.

Lee, J.M., Jr. and D.B. Griffith. 1978. Transmission line audible noise and wildlife, pp. 105-168. In Effect of noise on wildlife (J.M. Fletcher and R.G. Busnel, Eds.). Academic Press, New York, NY.

Martin, A.C., H.S. Zim, and A.L. Nelson. 1951. American wildlife and plants. Dover Publ., Inc., New York, NY.

Meyers, J.M., and E.E. Provost. 1979. Bird population responses to a forest-grassland and shrub ecotone on a transmission line corridor, pp. 60-1-60-13. In Proc. 2nd Symp. Enviro. Concerns in Rights-of-Way Mgmt. Univ. Michigan, Ann Arbor, MI.

National Academy of Science. 1977. Biological effects of electric and magnetic fields associated with proposed project seafarer. Report of the committee on biosphere effects of extreme low frequency radiation. Division of Medical Sciences, National Research Council.

Niemi, G.J. 1985. Patterns of morphological evolution in bird genera of new world and old world peatlands. Ecology 66: 1215-1288.

_________ and J.M. Hanowski. 1984. Effects of a transmission line on bird populations in the Red Lake Peatland, northern Minnesota. Auk 101: 487-498.

Raphael, M.G. 1987. Estimating relative abundance of forest birds: simple versus adjusted counts. Condor 89: 125-130.

Reese, K.P. and J.T. Ratti. 1988. Edge effect: a concept under scrutiny. Trans. 53rd N.A. Wildl. and Nat. Res. Conf. 127-136.

Richardson, W.J. 1978. Timing and amount of bird migration in relation to weather: a review. Oikos 30: 224-272.

Robinson, S.K. 1988. Reappraisal of the costs and benefits of habitat heterogeneity for nongame wildlife. Trans. 53rd N.A. Wildl. and Nat. Res. Conf. 145-155.

Rogers, L.E. 1981. Environmental studies of a 1100-kV prototype transmission line: an annual report for the 1980 study period. Rept. to U.S. Dept. Energy by Battelle Lab.

Small, M.F. and M.L. Hunter. 1989. Response of passerines to abrupt forest-river and forest-powerline edges in Maine. Wilson Bull. 101: 77-83.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.H. Freeman and Co., San Francisco, CA.

_________ and N.L. Oden. 1978. Spatial autocorrelation in biology 1. Methodology. Biol. J. Linnean Soc. 10: 199-228.

Stapleton, J., and E. Kiviat. 1979. Rights of bird populations and rights of way. Amer. Birds 33: 7-10.

Strelke, W.K. and J.G. Dickson. 1980. Effect of forest clear-cut edge on breeding birds in east Texas. J. Wildl. Manage. 44: 559-567.

Terres, J.K. 1982. The Audubon Society Encyclopedia of North American Birds. Alfred A. Knopf, New York, NY.

Verner, J. 1984 The guild concept applied to management of bird populations. Environ. Manage. 8: 1-14.

________. 1985. Assessment of counting techniques. p. 247-302. In R.F. Johnston (ed.). Current Ornithology. Vol. 2. Plenum Press, New York.

Wiens, J.A. 1969. An approach to the study of ecological relationships among grassland birds. Orn. Mono. No. 8, Allen Press, Lawrence, KS.

________, and J.T. Rotenberry. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecol. Monogr. 51: 21-41.

Wiltschko, W. and R. Wiltschko. 1980. Magnetic orientation in birds. Current Ornithology 5: 67-121. Plenum Press, New York.

Wilson, D.M. and J. Bart. 1985. Reliability of singing bird surveys: effects of song phenology during the breeding season. Condor 87: 69-73.

Yahner, R.H. and D.P. Scott. 1988. Effects of forest fragmentation on depredation of artificial nests. J. Wildl. Manage. 52: 158-161.

Appendix 1

Summary of Electric and Magnetic Field Intensities Measured on Wisconsin Transects in 1984 to 1989

a. Transverse Electric Field Intensities (V/m)
b. Longitudinal Electric Field Intensities (V/m)
c. Magnetic Flux Density (mG)
d. 60 Hz EM Field Measurements for 1984, 1985, and 1989
e. EM Field Variations Along Transects

Appendix 1a. Transverse Electric Field Intensities (V/m)--
Bird Species and Communities Studies,
Wisconsin Transects

SITE NO. MEAS. PT.	1984 76 Hz NS	1984 76 Hz EW	1985 76 Hz NS	1985 76 Hz EW	1985 76 Hz B	1986 76 Hz B	1987 76 Hz B	1988 76 Hz B	1989 76 Hz B	1989 44 Hz B
10C6-1	<	<	/	/	<	<	<	<	<	<
10C6-2	<	<	/	/	<	<	<	<	<	<
10C7-2	<	<	<	/	<	<	<	<	<	<
10C7-3	-	-	<	<	<	<	<	<	<	<
10C9-1	<	<	/	/	<	<	<	<	<	<
10C9-2	<	<	/	/	<	<	<	<	<	<
10C10-1	<	<	/	/	<	<	<	<	<	<
10C10-2	<	<	/	/	<	<	--	--	--	--
10C10-3	-	-	-	-	-	-	<	<	<	<
10C11-1	-	-	<	<	<	<	<	<	<	<
10C11-2	-	-	<	<	<	<	<	<	<	<
10T6-1	0.006	0.195	/	/	/	0.166	0.22	0.22	0.24	0.177
10T6-2	0.014	0.107	/	/	/	0.090	0.077	0.135	0.070	0.045
10T7-1	/	/	/	/	/	0.20	0.136	0.182	0.150	0.120
10T7-2	0.014	0.156	/	/	/	0.117	0.116	0.129	0.25	0.106
10T7-3	0.015	0.183	/	/	/	0.129	0.110	0.121	0.22	0.091
10T8-2	0.089	0.013	/	/	/	0.067	0.094	0.078	0.087	0.091
10T8-3	-	-	/	/	/	0.107	0.121	0.129	0.036	0.108
10T8-4	-	-	/	/	/	0.078	0.087	0.072	0.086	0.161
10T9-2	0.47	0.004	/	/	0.48	0.41	0.45	0.43	0.78	0.45
10T9-3	-	-	/	/	/	0.092	0.106	0.092	0.31	0.066
10T10-1	0.094	0.007	/	/	0.146	0.07	0.101	0.082	0.064	0.058
10T10-2	0.195	0.006	/	/	0.163	0.091	0.082	0.087	0.133	0.082

NS = north-south antenna.
EW = east-west antenna.
B = both antennas, standard phasing.
* = antenna current = 300 amperes.

- = measurement point not established.
-- = measurement point dropped.
/ = measurement not taken.
< = expected <0.002 V/m based on E in ground.

Appendix 1b. Longitudinal Electric Field Intensities (V/m)--
Bird Species and Communities Studies,
Wisconsin Transects

SITE NO. MEAS. PT.	1964 76 Hz NS	1964 76 Hz EW	1985 76 Hz NS	1985 76 Hz EW	1985 76 Hz B	1986 76 Hz B	1987 76 Hz B	1988 76 Hz B	1989 76 Hz B	1989 44 Hz B
10C6-1	1.60	1.08	/	/	1.20	1.12	1.32	0.86	1.28	2.4
10C6-2	1.89	1.61	/	/	2.7	2.3	2.9	2.9	1.90	4.2
10C7-2	0.47	0.43	0.48	/	0.64	0.59	0.67	0.61	0.62	0.80
10C7-3	-	-	0.25,0.34	0.36	0.59	0.62	0.54	0.64	0.23	0.33
10C9-1	1.16	0.44	/	/	0.95	1.12	1.05	1.04	0.63	1.04
10C9-2	1.44	1.08	/	/	1.77	2.0	2.12	2.3	1.60	8.2
10C10-1	1.40	1.12	/	/	1.98	1.55	1.83	1.55	1.23	1.33
10C10-2	0.30	0.31	/	/	0.48	0.55	--	--	--	--
10C10-3	-	-	-	-	-	-	0.37	0.32	0.23	0.166
10C11-1	-	-	0.67	0.59	1.44	1.63	1.10	1.23	0.58	0.93
10C11-2	-	-	0.98	0.91	2.0	1.91	0.81	1.42	1.84	2.1
10T6-1	6.0	130	/	/	157	184	260	250	178	144
10T6-2	12.8	88	14.1	95	77	82	78	56	43	77
10T7-1	20	180	/	/	210	210	145	194	140	123
10T7-2	13.2	142	/	/	137	99	119	121	109	97
10T7-3	18.7	159	/	/	104	101	121	97	104	62
10T8-2	102	15.2	/	/	81	90	84	115	89	55
10T8-3	-	-	150	13.2	121	114	128	125	140	83
10T8-4	-	-	73,85	23,24	71	63	70	86	86	180
10T9-2	470	3.5	/	/	350	470	470	566	190	390
10T9-3	-	-	81	7.8	71	88	114	89	95	65
10T10-1	73	11.0	77	10.5	109	96	90	98	84	51
10T10-2	150	6.5	130	11.2	158	94	92	88	96	67

NS = north-south antenna.
EW = east-west antenna.
B = both antennas, standard phasing.
* = antenna current = 300 amperes.

- = measurement point not established.
-- = measurement point dropped.
/ = measurement not taken.

Appendix 1c. Magnetic Flux Density (mG)--
Bird Species and Communities Studies,
Wisconsin Transects

SITE NO. MEAS. PT.	1984 76 Hz NS	1984 76 Hz EW	1985 76 Hz NS	1985 76 Hz EW	1985 76 Hz B	1986 76 Hz B	1987 76 Hz B	1988 76 Hz B	1989 76 Hz B	1989 44 Hz B
10C6-1	0.011	0.010	/	/	0.012	0.013	0.013	0.014	0.013	0.026
10C6-2	0.012	0.014	/	/	0.016	0.017	0.018	0.019	0.019	0.029
10C7-2	0.005	0.005	0.005	/	0.007	0.007	0.008	0.007	0.005	0.009
10C7-3	-	-	0.004,0.005	0.005	0.007	0.006	0.007	0.007	0.006	0.008
10C9-1	0.030	0.017	/	/	0.035	0.037	0.037	0.040	0.034	0.042
10C9-2	0.022	0.015	/	/	0.027	0.027	0.027	0.027	0.029	0.041
10C10-1	0.017	0.014	/	/	0.023	0.023	0.025	0.024	0.026	0.036
10C10-2	0.008	0.007	/	/	0.011	0.011	--	--	--	--
10C10-3	-	-	-	-	-	-	0.012	0.012	0.012	0.015
10C11-1	-	-	/	/	0.011	0.011	0.011	0.011	0.008	0.014
10C11-2	-	-	0.009	<0.001	0.014	0.014	0.014	0.015	0.015	0.017
10T6-1	0.041	3.6	/	/	8.8	9.0	9.0	10.2	9.2	9.7
10T6-2	0.069	7.5	0.082	7.8	7.1	9.6	7.7	8.2	8.4	8.6
10T7-1	0.061	4.7	/	/	4.4	4.2	5.2	4.8	4.8	4.9
10T7-2	0.059	2.3	/	/	2.2	2.2	2.3	2.3	2.4	2.4
10T7-3	0.094	4.9	/	/	4.7	4.6	4.8	5.1	4.9	5.1
10T8-2	4.9	0.136	/	/	4.8	4.9	5.0	5.2	5.1	5.0
10T8-3	-	-	9.9	0.127	8.1	8.4	8.5	8.5	8.8	9.0
10T8-4	-	-	3.4,6.6	0.192	3.4	3.4	3.6	3.6	3.7	3.5
10T9-2	1.58	0.033	/	/	2.4	2.2	2.2	2.1	2.2	2.3
10T9-3	-	-	4.1	0.072	3.4	3.7	3.9	3.8	3.2	3.2
10T10-1	4.5	0.063	4.5	0.066	5.7	4.3	4.5	4.5	4.6	4.4
10T10-2	4.9	0.050	3.7	0.042	4.7	3.9	3.9	4.0	4.2	4.1

NS = north-south antenna.
EW = east-west antenna.
B = both antennas, standard phasing.
* = antenna current = 300 amperes.

\- = measurement point not established.
\-- = measurement point dropped.
/ = measurement not taken.

Appendix 1d. 60 Hz EM Field Measurements for 1984, 1985, and 1989--
Bird Species and Communities Studies,
Wisconsin Transects

SITE NO., MEAS. PT.	TRANSVERSE ELECTRIC FIELD INTENSITY (V/m)			LONGITUDINAL ELECTRIC FIELD INTENSITY (mV/m)			MAGNETIC FLUX DENSITY (mG)		
	1984	1985	1989	1984	1985	1989	1984	1985	1989
10C6-1	<	<	<	0.063	0.098	0.075	0.001	0.001	0.001
10C6-2	<	<	<	0.100	0.089	0.086	0.001	<0.001	0.001
10C7-2	<	<	<	0.053	0.051,0.055	0.044	<0.001	<0.001	<0.001
10C7-3	-	<	<	-	0.074, 0.93, 0.104, 0.27	0.303	-	0.001,<0.001	<0.001
10C9-1	<	<	<	0.098	0.21	0.23	0.001	0.002	0.002
10C9-2	<	<	<	0.013	0.065	0.062	<0.001	<0.001	0.001
10C10-1	<	<	<	0.016	0.055	0.020	<0.001	<0.001	<0.001
10C10-2	<	<	--	0.024	0.053	--	0.001	0.001	--
10C10-3	-	-	<	-	-	0.015	-	-	<0.001
10C11-1	-	<	<	-	0.23,0.32	0.25	-	0.002	0.002
10C11-2	-	<	<	-	0.038, 0.040, 0.071	0.035	-	0.001,<0.001	0.001
10T6-1	<0.001	<	<0.001	0.044	0.033	0.042	<0.001	0.001	0.001
10T6-2	<0.001	<	<0.001	0.022	0.020	0.026	0.001	0.001	0.001
10T7-1	<	<	<	0.040	0.047	0.061	0.001	0.001	0.001
10T7-2	<0.001	<	<0.001	0.100	0.087	0.127	<0.001	0.001	0.001
10T7-3	<0.001	<	0.002	0.096	0.066	0.110	0.001	0.001	0.002
10T8-2	<0.001	<	<	0.045	0.040	0.044	0.001	0.002	<0.001
10T8-3	-	<	<0.001	-	0.100,0.110	0.132	-	0.002,0.003	0.001
10T8-4	-	<	<0.001	-	0.032,0.038	0.017	-	0.001,0.002	0.001
10T9-2	<0.001	<	<0.001	0.130	0.071	0.112	<0.001	<0.001	0.001
10T9-3	-	<	<0.001	-	0.028,0.036	0.038	-	0.002,<0.001	0.001
10T10-1	<0.001	<	<	0.040	0.074	0.026	0.001	0.001	<0.001
10T10-2	<0.001	<	<0.001	0.091	0.126	0.023	0.001	0.001	<0.001

\- = measurement point not established.
-- = measurement point dropped.
< = expected <0.001 V/m based on E in ground.

Appendix 1e. EM Field Variations Along Transects--
Bird Species and Communities Studies,
Wisconsin Transects (page 1 of 2)

Study transect	Sub-transect location	Magnetic flux density (mG)	Electric field intensity (mV/m)
10C7-3	Start A	0.0066	0.64
10C7	A-X-B	0.0061	1.13
10C7	B-X-C	0.0063	1.35
10C7	C-X-D	0.0064	0.83
10C7	D-X-E	0.0068	0.40
10C7	E-X-F	0.0070	0.45
10C7-2	F-14	0.0074	0.61
10C7	F-X-G	0.0077	0.97
10C7	G-X-H	0.0079	0.99
10C7	End H	0.0084	1.29
10T6	Start A	4.3	103
10T6	A-X-B	6.1	121
10T6	B-X-C	4.3	95
10T6	C-X-D	5.6	116
10T6	D-X-E	6.5	81
10T6	E-X-F	7.6	78
10T6	F-X-G	3.6	140
10T6-2	G-X-H	8.4	43
10T6	End H	9.7	117
10T7-1	Start A	4.8	140
10T7	A-X-B	4.5	117
10T7	B-X-C	2.5	76
10T7-2	C8	2.4	109
10T7	C-X-D	2.3	51
10T7	D-X-E	9.4	152
10T7	E-X-F	5.2	106
10T7	F-X-G	7.6	133
10T7	G-X-H	4.6	99
10T7-3	H8	4.9	104
10T7	End H	4.6	98

Notes: Measurements taken at "X" flag between sub-transects except as noted.
Antenna conditions: 300 Amperes, 76 Hz.
Transects 10T6, 10T7, 10T9 and 10T10 measured in 1989.
Transects 10C7 and 10T8 measured in 1988.

Appendix 1e. EM Field Variations Along Transects--
Bird Species and Communities Studies,
Wisconsin Transects (page 2 of 2)

Study transect	Sub-transect location	Magnetic flux density (mG)	Electric field intensity (mV/m)
10T8	Start B	6.7	80
10T8-3	B-X-C	8.5	125
10T8	C-X-D	7.6	88
10T8	D-X-E	6.9	166
10T8	E-X-F	7.5	96
10T8-2	Hwy GG	5.2	115
10T8	F-X-G	12.1	162
10T8	G-X-H	5.9	119
10T8	H-X-I	3.5	216
10T8-4	I-13	3.6	90
10T8	I-X-J	4.0	105
10T8	End J	3.1	73
10T9	Start B	5.4	101
10T9	B-X-C	2.6	140
10T9	C-X-D	4.9	127
10T9	D-X-E	2.7	90
10T9	E-X-F	2.2	127
10T9	F-X-G	2.7	260
10T9	G-X-H	2.7	126
10T9-2	H9	2.2	190
10T9	END H	1.42	140
10T10-1	Start A	4.6	84
10T10	Start B	4.4	84
10T10	B-X-C	5.4	112
10T10	C-X-D	7.3	166
10T10	D-X-E	8.0	97
10T10	E-X-F	4.2	80
10T10-2	F6	4.2	96
10T10	F-X-G	5.3	53
10T10	G-X-H	3.4	52
10T10	End H	3.4	175

Notes: Measurements taken at "X" flag between sub-transects except as noted.
Antenna conditions: 300 Amperes, 76 Hz.
Transects 10T6, 10T7, 10T9 and 10T10 measured in 1989.
Transects 10C7 and 10T8 measured in 1988.

Appendix 2

Nesting, Feeding, Habitat, and Migration Classifications for Bird Species Observed in Wisconsin

Appendix 2. Nesting, feeding, habitat, and migration classification for bird species observed in Wisconsin.

Species	Nesting	Food	Habitat	Migration
Common Loon	1	1	9,8	2
Pied-billed Grebe	1	1	9,8	2
American Bittern	3	1	6,9	2
Great Blue Heron	2	1	9,1,2,3	2
Wood Duck	4	18	9,1	2
Mallard	1	18	9,8	2
Blue-winged Teal	1	18	9,8	3,2
Turkey Vulture	1	3	3,1,5	2,3
Osprey	2	1	9,3	2,3
Bald Eagle	2	1	9,3	2,1
Northern Harrier	1	2	8,5,10	2,3
Sharp-shinned Hawk	2	2	2,3,11	2
Cooper's Hawk	2	2	1,3	2
Northern Goshawk	2	2	2,3	4,1
Broad-winged Hawk	2	2	3,1	3
Red-tailed Hawk	2	2	5,1	2
American Kestrel	4	2	5,4	2,3
Spruce Grouse	1	4	2,11	1
Ruffed Grouse	1	4	1,3,4	1
Virginia Rail	3	19	6,8	2

Appendix 2 (continued)

Species	Nesting	Food	Habitat	Migration
Sora	3	19,18	8,6	2
Sandhill Crane	1	5	8,5,10	2
Solitary Sandpiper	2,3	19	9	3
Spotted Sandpiper	1	19	9	2,3
Common Snipe	1	19	8,6,5	2
American Woodcock	1	6	6,5,4,1	2
Mourning Dove	2,3	7	5,7	2
Black-billed Cuckoo	3	10	1,4,6	3
Yellow-billed Cuckoo	3	10	1,4,6	3
Great Horned Owl	2	2	3,2,1	1
Barred Owl	2	2	1,3	1
Common Nighthawk	1	11	3,7,4	3
Whip-poor-will	1	11	1,3,4	2
Chimney Swift	4	11	7,3,1	3
Ruby-throated Hummingbird	2	17	5,7,4	3
Belted Kingfisher	4	1	9	2
Yellow-bellied Sapsucker	4	17,16	1,3,2	2
Downy Woodpecker	4	16	1,4,3	1
Hairy Woodpecker	4	16	1,3,4	1
Black-backed Woodpecker	4	16	2,11,3	1
Northern Flicker	4	9	1,3,2	2
Pileated Woodpecker	4	16	1,3,2	1

Appendix 2 (continued)

Species	Nesting	Food	Habitat	Migration
Olive-sided Flycatcher	2	12	4,11,2	3
Eastern Wood-Pewee	2	12	3,1,2	3
Yellow-bellied Flycatcher	1	12	11,2	3
Alder Flycatcher	3	12	6	3
Least Flycatcher	2	12	1,3,4	3
Eastern Phoebe	5	12	9,7	2
Great Crested Flycatcher	4	12	1,3	3
Eastern Kingbird	2,3	12	5,4,10,8	3
Tree Swallow	4	11	5,7,4,9	2,3
Gray Jay	2	5	11,3,2	1
Blue Jay	2	5	1,3,2	1
American Crow	2	5	5,1,3,7	2,1
Common Raven	2	5	2,3,7	1
Black-capped Chickadee	4	10	1,3,11,2	1
Boreal Chickadee	4	10	11,2	1
Red-breasted Nuthatch	4	16	2,3,11,1	1
White-breasted Nuthatch	4	16	1,3	1
Brown Creeper	4	16	1,3,2,11	2,1
House Wren	4	10	7,4	2
Winter Wren	1,6	10	3,11,4,2	2
Sedge Wren	3	10	8,6,5	2
Marsh Wren	3	10	8	2

Appendix 2 (continued)

Species	Nesting	Food	Habitat	Migration
Golden-crowned Kinglet	2	10	2,11	2,1
Ruby-crowned Kinglet	2	10	2,11,4,6	2
Veery	1	9	1,4,3,6	3
Gray-cheeked Thrush	3	9	4,11,2	3
Swainson's Thrush	2,3	9	11,2,4	3
Hermit Thrush	1	9	3,11,1,2	2
Wood Thrush	3,1	9	1,3	3
American Robin	2,3,1	9	5,7,4,1	2,1
Gray Catbird	3	13	4,6,7	2,3
Brown Thrasher	3	9	4,7	2
Bohemian Waxwing	2	14	4,3,1	4
Cedar Waxwing	2	14	4,3,1	1,2
European Starling	4	9	7,3	1
Solitary Vireo	2	10	3,11,2	3,2
Yellow-throated Vireo	2	10	1,3	3
Warbling Vireo	2	10	4,3,1	3
Philadelphia Vireo	2,3	10	1,3,6	3
Red-eyed Vireo	2,3	10	1,3,4	3
Golden-winged Warbler	1,3	10	4,6	3
Tennessee Warbler	1	10	3,2,6,4	3
Orange-crowned Warbler	1	10	6,4,3	2,3
Nashville Warbler	1	10	3,4,11,2	3

Appendix 2 (continued)

Species	Nesting	Food	Habitat	Migration
Northern Parula	2	10	11,3,2	3
Yellow Warbler	3	10	6,5,7	3
Chestnut-sided Warbler	3	10	4,3	3
Magnolia Warbler	2,3	10	4,2,3	3
Cape May Warbler	2	10	2,3	3
Black-throated Blue Warbler	3	10	1,3,4	3
Yellow-rumped Warbler	2	13	2,3,11,4	2,3
Black-throated Green Warbler	2	10	3,1	3
Blackburnian Warbler	2	10	2,3	3
Pine Warbler	2	10	2	2
Palm Warbler	1	6	11,10	2,3
Bay-breasted Warbler	2	10	2,3	3
Blackpoll Warbler	2	10	2,4,3	3
Black-and-white Warbler	1	16	3,4,6,1	3
American Redstart	2,3	12,10	4,1,6	3
Ovenbird	1	6	1,3,2,4	3
Northern Waterthrush	1,6	6	9	3
Connecticut Warbler	1	10	11	3
Mourning Warbler	1,3	10	4,3	3
Common Yellowthroat	3	10	6,8,4	2,3
Wilson's Warbler	3	10	6	3
Canada Warbler	3	10	3,4	3

Appendix 2 (continued)

Species	Nesting	Food	Habitat	Migration
Scarlet Tanager	3	10	1,3	3
Rose-breasted Grosbeak	3,2	13	1,4,3	3
Indigo Bunting	3	15	5,4	3
Rufous-sided Towhee	1,2,3	8	4	2
American Tree Sparrow	3	7	5	4,2
Chipping Sparrow	2	8	2,3,4,11	2
Clay-colored Sparrow	3	8	5,6	2,3
Field Sparrow	1,3	8	5	2
Savannah Sparrow	1	8	5,8,10	2
Fox Sparrow	1,3	8	4,5	2
Song Sparrow	3	8	5,4,6	2
Lincoln's Sparrow	1	8	10,8,4	2
Swamp Sparrow	3	8	6,8	2
White-throated Sparrow	1	8	4,3,2,11,1	2
White-crowned Sparrow	1,3	8	4,6,5	2
Dark-eyed Junco	1	8	11,2,3,4	2,1
Snow Bunting	5	7	5	4
Bobolink	1	8	5,8	3
Red-winged Blackbird	3	8	8	2
Eastern Meadowlark	1	6	5	2
Western Meadowlark	1	6	5	2
Yellow-headed Blackbird	3	8	8	2

Appendix 2 (continued)

Species	Nesting	Food	Habitat	Migration
Rusty Blackbird	3	8	9	2
Brewer's Blackbird	3,1	8	5	2
Common Grackle	3	5	5,9,7	2
Brown-headed Cowbird	7	8	5,4,1,7	2
Northern Oriole	2	13	1,3	3
Pine Grosbeak	2	7	2,11	4
Purple Finch	2	7	3,2,4	2,1
Red Crossbill	2	7	2,11,3	4,1
White-winged Crossbill	2	7	2,11,3	4,1
Common Redpoll	3	7	5	4
Hoary Redpoll	3	7	5	4
Pine Siskin	2	15	2,3	1,4
American Goldfinch	3,2	7	5,6,4	2
Evening Grosbeak	2	15	3,2,7	1,4
House Sparrow	4	7	7	1

A. Nesting

1 Ground

2 Canopy or canopy vegetation (tree but not necessarily tree top)

3 Subcanopy or shrub

4 Cavity, hole or bank

Appendix 2 (continued)

5 Ledge or platform

6 Cavity - tree roots

7 Nest parasite

B. Food

1 Aquatic vertebrates, including fish or other aquatic vertebrates

2 Birds, small mammals, large insects

3 Carrion

4 Vegetation such as buds, pine needles, and seeds but excluding species concentrating on seeds or fruits

5 Various small vertebrates (including eggs and young), invertebrates, plants, carrion, etc. (e.g., Omnivores)

6 Ground invertebrates

7 Seeds (plus a smaller amount of fruit by some species)

8 Ground invertebrates and seeds

9 Ground invertebrates and fruit

10 Foliage invertebrates

11 Aerial insects - taken while in continuous flight

12 Aerial insects - taken in sallies from a perch

13 Foliage invertebrates and fruit

14 Fruit

15 Foliage invertebrates and seeds

16 Bark insects

17 Nectar and sap

Appendix 2 (continued)

18 Aquatic vegetation

19 Aquatic invertebrates

C. Habitat

1 Deciduous forest

2 Coniferous forest

3 Mixed deciduous - coniferous forest

4 Early successional deciduous - coniferous forest

5 Fields and meadows

6 Shrub swamp

7 Urban

8 Open wetlands (e.g., sedge fen, cattail)

9 Ponds, lakes, rivers, and streams

10 Muskeg

11 Lowland coniferous forest

D. Migration

1 Permanent resident; populations may be augmented during winter or during summer

2 Short-distance migrant; generally includes breeders; individuals generally winter south of study areas but most winter north of the tropics

3 Long-distance migrant; generally winter south of the U.S.

4 Winter resident

Appendix 3

Description of Habitat Variables Used to Quantify Habitat Characteristics of Study Areas

Appendix 3. Description of habitat variables used to quantify habitat characteristics of study areas.

Habitat Variable	Description
Ground Cover	Estimate of percent of green vegetation less than 10 cm high in m^2 surrounding the center point
Water Cover	Estimate of percent of standing water in m^2 surrounding the center point
Water Depth	Depth at center point
Overall Height	Estimate of the average height of vegetation in 25 m^2 surrounding center point
Tree Density	Density of trees greater than 2.5 cm diameter breast height (dbh) measured by the point-centered quarter method
Tree Height	Height of four trees measured for tree density; measured with a clinometer
Tree Species	Identification of four trees measured for tree density
Tree Diameter	Measured dbh of four trees measured for tree density
Canopy Cover	Average of four readings taken with a spherical densiometer in NE quarter of point-centered plot
Log Density	Density of fallen logs greater than 2.5 cm diameter measured by the point-centered quarter method
Log Species	Identification of four logs measured for log density
Log Diameter	Measured diameter of four logs measured for log density. Diameter was measured at point where log was closest to center point.
Shrub Density	Density of shrubs greater than 30 cm high and less than 2.5 cm dbh measured by the point-centered method. Shrubs were defined as any plant species that was persistent in the environment year round at a height of at least 30 cm (e.g., woody shrubs and cattails)
Shrub Height	Height of four shrubs measured for shrub density

Appendix 3 (continued)

Habitat Variable	Description
Shrub Species	Species of four shrubs measured for shrub density
Forb Density	Density of forbs > 10 cm high measured by the point-centered method
Forb Species	Species of four forbs measured for forb density
Grass-Sedge Density	Density of grasses and sedges > 10 cm high measured by the point-centered quarter method

Appendix 4

Total Number of Individuals and Species Observed on Control (C) and Treatment (T) Transects in Wisconsin During Four Years in May, June, July, August, and September

a. Total Number Observed During Four Years in May
b. Total Number Observed During Four Years in June
c. Total Number Observed During Four Years in July
d. Total Number Observed During Four Years in August
e. Total Number Observed During Four Years in September

Appendix 4a. Total number of individuals and species observed on control (C) and treatment (T) transects in Wisconsin during four years in May. English and scientific names follow AOU (1983, 1985).

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Common Loon Gavia immer	0	0	0	0	2	0	0	0	2	0
American Bittern Botaurus lentiginosus	2	0	0	0	0	1	1	0	3	1
Great Blue Heron Ardea herodias	0	0	0	1	0	1	0	0	0	2
Wood Duck Aix sponsa	1	0	2	3	1	8	1	0	5	11
Green-winged Teal Anas crecca	0	0	0	0	0	2	0	0	0	2
Mallard Anas platyrhynchos	0	0	0	0	0	1	0	4	0	5
Blue-winged Teal Anas discors	0	0	0	0	1	0	0	0	1	0
Hooded Merganser Lophodytes cucullatus	0	0	0	0	0	0	0	3	0	3
Sharp-shinned Hawk Accipiter striatus	0	0	0	0	0	1	0	0	0	1
Broad-winged Hawk Buteo platypterus	2	0	0	2	0	1	2	2	4	5
Red-tailed Hawk Buteo jamaicensis	0	0	0	1	0	0	0	0	0	1
Ruffed Grouse Bonasa umbellus	19	17	9	16	16	31	14	20	58	84
Sandhill Crane Grus canadensis	0	0	0	0	1	0	0	0	1	0
Common Snipe Gallinago gallinago	4	0	1	0	1	0	0	1	6	1
American Woodcock Scolopax minor	0	0	1	2	0	0	2	1	3	3

Appendix 4a (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Barred Owl Strix varia	0	0	0	1	2	0	1	1	2	2
Chimney Swift Chaetura pelagica	0	0	0	4	0	2	1	0	1	6
Belted Kingfisher Ceryle alcyon	0	0	0	1	1	0	0	1	1	2
Yellow-bellied Sapsucker Sphyrapicus varius	12	9	8	3	15	16	11	23	46	51
Downy Woodpecker Picoides pubescens	1	0	2	2	2	0	0	2	5	4
Hairy Woodpecker Picoides villosus	1	3	2	1	8	4	3	2	14	10
Black-backed Woodpecker Picoides arcticus	0	0	0	0	0	2	1	3	1	5
Northern Flicker Colaptes auratus	9	12	11	14	9	4	2	3	31	33
Pileated Woodpecker Dryocopus pileatus	0	2	0	0	0	0	3	1	3	3
Olive-sided Flycatcher Contopus borealis	0	0	1	2	3	2	1	1	5	5
Eastern Wood-Pewee Contopus virens	1	1	0	4	0	4	0	3	1	12
Yellow-bellied Flycatcher Empidonax flaviventris	10	7	9	10	7	10	10	12	36	39
Alder Flycatcher Empidonax alnorum	0	0	0	5	0	0	2	0	2	5
Least Flycatcher Empidonax minimus	21	56	9	46	21	46	21	34	72	182
Eastern Phoebe Sayornis phoebe	0	1	0	C	0	0	1	0	1	1
Great Crested Flycatcher Myiarchus crinitus	1	3	4	15	7	9	8	13	20	40

Appendix 4a (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Eastern Kingbird Tyrannus tyrannus	0	2	0	0	0	1	0	0	0	3
Tree Swallow Tachycineta bicolor	1	1	4	4	2	8	5	0	12	13
Gray Jay Perisoreus canadensis	1	3	1	0	1	0	3	1	6	4
Blue Jay Cyanocitta cristata	50	45	50	28	49	43	35	25	184	141
American Crow Corvus brachyrhynchos	1	2	0	0	4	4	0	2	5	8
Common Raven Corvus corax Linnaeus	4	0	1	0	0	3	0	0	5	3
Black-capped Chickadee Parus atricapillus	17	13	19	13	44	40	29	24	109	90
Boreal Chickadee Parus hudsonicus	0	2	1	0	1	2	0	0	2	4
Red-breasted Nuthatch Sitta canadensis	8	6	8	11	34	45	15	7	65	69
White-breasted Nuthatch Sitta carolinensis	0	2	0	1	4	7	2	1	6	11
Brown Creeper Certhia americana	1	2	2	1	8	5	6	13	17	21
Winter Wren Troglodytes troglodytes	24	24	25	27	14	17	24	53	87	121
Sedge Wren Cistothorus platensis	6	0	5	0	2	0	5	0	18	0
Marsh Wren Cistothorus palustris	0	0	0	0	1	2	0	0	1	2
Golden-crowned Kinglet Regulus satrapa	24	15	24	22	27	22	42	18	117	77

Appendix 4a (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Ruby-crowned Kinglet Regulus calendula	1	0	4	0	7	2	1	0	13	2
Veery Catharus fuscescens	2	2	0	1	5	2	1	0	8	5
Swainson's Thrush Catharus ustulatus	0	0	1	0	0	0	0	0	1	0
Gray-cheeked Thrush Catharus minimus	0	0	1	0	0	0	0	0	1	0
Hermit Thrush Catharus guttatus	18	23	25	21	34	29	43	32	120	105
Wood Thrush Hylocichla mustelina	17	17	0	3	1	2	0	0	18	22
American Robin Turdus migratorius	33	24	7	12	21	19	43	22	104	77
Gray Catbird Dumetella carolinensis	1	1	2	0	0	0	0	0	3	1
Brown Thrasher Toxostoma rufum	2	1	1	1	1	1	1	0	5	3
European Starling Sturnus vulgaris	0	1	0	0	0	0	0	0	0	1
Solitary Vireo Vireo solitarius	4	6	2	1	10	14	4	11	20	32
Yellow-throated Vireo Vireo flavifrons	1	0	0	0	0	0	0	0	1	0
Warbling Vireo Vireo gilvus	0	1	0	0	0	0	0	0	0	1
Philadelphia Vireo Vireo philadelphicus	1	0	1	0	0	0	2	1	4	1
Red-eyed Vireo Vireo olivaceus	70	72	55	80	42	48	30	41	197	241
Golden-winged Warbler Vermivora chrysoptera	5	8	13	13	11	7	15	7	44	35

Appendix 4a (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Tennessee Warbler <u>Vermivora peregrina</u>	26	30	8	14	6	4	2	2	42	50
Nashville Warbler <u>Vermivora ruficapilla</u>	256	263	181	190	80	103	100	70	617	626
Northern Parula <u>Parula americana</u>	10	45	21	35	19	22	13	22	63	124
Yellow Warbler <u>Dendroica petechia</u>	4	0	3	2	5	0	4	3	16	5
Chestnut-sided Warbler <u>Dendroica pensylvanica</u>	88	70	81	61	88	44	86	60	343	235
Magnolia Warbler <u>Dendroica magnolia</u>	9	1	14	2	2	1	5	1	30	5
Cape May Warbler <u>Dendroica tigrina</u>	17	3	8	0	0	0	0	0	25	3
Black-throated Blue Warbler <u>Dendroica caerulescens</u>	0	0	2	0	0	0	0	0	2	0
Yellow-rumped Warbler <u>Dendroica coronata</u>	32	23	17	12	37	40	30	18	116	93
Black-throated Green Warbler <u>Dendroica virens</u>	83	103	68	75	72	73	53	82	276	333
Blackburnian Warbler <u>Dendroica fusca</u>	12	13	19	29	17	14	8	17	56	73
Pine Warbler <u>Dendroica pinus</u>	1	1	3	1	2	0	0	0	6	2
Palm Warbler <u>Dendroica palmarum</u>	9	2	14	0	5	1	3	1	31	4
Bay-breasted Warbler <u>Dendroica castanea</u>	0	0	3	4	0	0	1	0	4	4
Blackpoll Warbler <u>Dendroica striata</u>	0	5	0	1	0	0	0	0	0	6
Black-and-white Warbler <u>Mniotilta varia</u>	40	80	41	59	41	49	30	51	152	239

Appendix 4a (continued)

	1986 T	1986 C	1987 T	1987 C	1988 T	1988 C	1989 T	1989 C	All years T	All years C
American Redstart <u>Setophaga</u> <u>ruticilla</u>	0	0	1	0	0	0	0	1	1	1
Ovenbird <u>Seiurus</u> <u>aurocapillus</u>	205	270	181	254	140	171	153	215	679	910
Northern Waterthrush <u>Seiurus</u> <u>noveboracensis</u>	3	2	2	2	0	2	3	1	8	7
Connecticut Warbler <u>Oporornis</u> <u>agilis</u>	0	6	4	0	2	3	0	0	6	9
Mourning Warbler <u>Oporornis</u> <u>philadelphia</u>	8	10	12	2	3	7	5	9	28	28
Common Yellowthroat <u>Geothylpis</u> <u>trichas</u>	47	29	35	17	29	22	32	17	143	85
Canada Warbler <u>Wilsonia</u> <u>canadensis</u>	12	2	5	17	3	6	5	9	25	34
Scarlet Tanager <u>Piranga</u> <u>olivacea</u>	13	7	8	8	4	7	2	8	27	30
Rose-breasted Grosbeak <u>Pheucticus</u> <u>ludovicianus</u>	5	29	24	39	9	16	21	23	59	107
Indigo Bunting <u>Passerina</u> <u>cyanea</u>	3	0	1	1	0	0	0	0	4	1
Chipping Sparrow <u>Spizella</u> <u>passerina</u>	15	12	10	1	19	4	25	3	69	20
Lark Sparrow <u>Chondestes</u> <u>grammacus</u>	0	0	0	0	4	0	3	0	7	0
Savannah Sparrow <u>Passerculus</u> <u>sandwichensis</u>	0	2	0	0	0	0	0	0	0	2
Song Sparrow <u>Melospiza</u> <u>melodia</u>	21	9	17	17	25	13	10	6	73	45
Lincoln's Sparrow <u>Melospiza</u> <u>lincolnii</u>	5	0	5	3	0	0	2	0	12	3
Swamp Sparrow <u>Melospiza</u> <u>georgianna</u>	11	0	18	0	10	1	13	1	52	2

Appendix 4a (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
White-throated Sparrow <u>Zonotrichia</u> <u>albicollis</u>	99	83	156	113	70	74	73	65	398	335
Dark-eyed Junco <u>Junco</u> <u>hyemalis</u>	0	0	2	0	0	0	1	1	3	1
Red-winged Blackbird <u>Agelaius</u> <u>phoeniceus</u>	9	8	7	7	5	4	3	4	24	23
Common Grackle <u>Quiscalus</u> <u>quiscula</u>	0	2	1	7	2	9	0	5	3	23
Brown-headed Cowbird <u>Molothrus</u> <u>ater</u>	4	1	1	9	1	0	3	15	9	25
Northern Oriole <u>Icterus</u> <u>galbula</u>	0	0	1	1	0	2	1	0	2	3
Purple Finch <u>Carpodacus</u> <u>purpureus</u>	8	8	17	8	5	3	8	7	38	26
Pine Siskin <u>Carduelis</u> <u>pinus</u>	0	0	0	1	0	2	1	0	1	3
American Goldfinch <u>Carduelis</u> <u>tristis</u>	4	0	6	0	8	7	2	1	20	8
Evening Grosbeak <u>Coccothraustes</u> <u>vespertinus</u>	4	6	17	0	0	0	4	7	25	13
Unidentified passerine	37	38	35	30	21	28	32	24	125	120
Unidentified woodpecker	1	3	4	3	12	15	1	4	18	25
Total individuals	1477	1550	1363	1397	1166	1215	1129	1141	5135	5303
Total species	67	63	72	66	67	68	70	64	93	95

Appendix 4b. Total number of individuals and species observed on control (C) and treatment (T) transects in Wisconsin during five years in June. English and scientific names follow AOU (1983, 1985).

	1985		1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C	T	C
Common Loon *Gavia immer*	0	0	0	0	0	0	0	2	0	0	0	2
Pied-billed Grebe *Podilymbus podiceps*	0	0	0	0	0	0	0	0	1	0	1	0
American Bittern *Botaurus lentiginosus*	1	0	0	0	0	0	0	0	1	0	2	0
Great Blue Heron *Ardea herodias*	1	1	0	0	1	1	1	2	0	0	3	4
Green-backed Heron *Butorides striatus*	1	0	0	0	0	0	0	0	0	0	1	0
Wood Duck *Aix sponsa*	0	3	0	0	0	1	0	7	0	0	0	11
Mallard *Anas platyrhynchos*	0	0	0	0	0	0	0	0	0	1	0	1
Red-breasted Merganser *Mergus serrator*	0	0	0	0	0	0	0	1	0	0	0	1
Broad-winged Hawk *Buteo platypterus*	1	1	2	2	2	3	0	1	1	2	6	9
Red-tailed Hawk *Buteo jamaicensis*	0	0	0	0	0	0	3	0	1	0	4	0
Ruffed Grouse *Bonasa umbellus*	2	13	3	3	1	8	6	19	4	6	16	49
Common Snipe *Gallinago gallinago*	3	0	1	0	0	0	0	0	0	0	4	0
American Woodcock *Scolopax minor*	0	0	1	0	1	2	1	0	2	2	5	4
Mourning Dove *Zenaida macroura*	0	0	0	0	0	0	1	0	0	0	1	0
Black-billed Cuckoo *Coccyzus erythroptalmus*	2	1	0	0	0	0	0	0	0	0	2	1
Yellow-billed Cuckoo *Coccyzus americanus*	0	0	0	0	0	0	0	1	0	0	0	1
Barred Owl *Strix varia*	0	0	2	0	0	0	0	0	0	0	2	0

Appendix 4b (continued)

	1985		1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C	T	C
Chimney Swift _Chaetura pelagica_	0	0	0	0	5	5	0	0	1	2	6	7
Ruby-throated Hummingbird _Archilochus colubris_	1	0	1	0	1	0	0	0	1	0	4	0
Belted Kingfisher _Ceryle alcyon_	0	0	0	0	0	0	0	0	0	1	0	1
Yellow-bellied Sapsucker _Sphyrapicus varius_	0	3	12	16	16	12	9	9	15	14	52	54
Downy Woodpecker _Picoides pubescens_	2	4	2	7	1	2	2	2	2	1	9	16
Hairy Woodpecker _Picoides villosus_	2	5	9	4	4	2	3	0	3	2	21	13
Black-backed Woodpecker _Picoides arcticus_	0	1	0	0	0	0	0	3	0	1	0	5
Northern Flicker _Colaptes auratus_	3	7	4	5	4	4	3	3	5	7	19	26
Pileated Woodpecker _Dryocopus pileatus_	1	5	2	0	1	1	1	0	0	1	5	7
Olive-sided Flycatcher _Contopus borealis_	1	3	3	0	3	2	3	2	4	1	14	8
Eastern Wood-Pewee _Contopus virens_	18	13	3	10	4	16	2	14	5	10	32	63
Yellow-bellied Flycatcher _Empidonax flaviventris_	25	62	32	25	36	45	31	29	30	37	154	198
Alder Flycatcher _Empidonax alnorum_	25	8	10	4	13	6	5	4	4	3	57	25
Least Flycatcher _Empidonax minimus_	36	64	20	27	21	33	10	24	32	24	119	172
Great Crested Flycatcher _Myiarchus crinitus_	16	39	3	15	6	17	4	6	6	5	35	82
Eastern Kingbird _Tyrannus tyrannus_	1	2	0	1	0	0	0	1	0	1	1	5
Tree Swallow _Tachycineta bicolor_	0	0	0	0	0	2	0	6	0	0	0	8
Gray Jay _Perisoreus canadensis_	2	0	2	3	6	4	4	0	1	0	15	7
Blue Jay _Cyanocitta cristata_	31	22	34	26	49	34	31	17	25	20	170	119

Appendix 4b (continued)

	1985		1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C	T	C
American Crow Corvus brachyrhynchos	10	0	0	0	0	1	2	1	1	0	13	2
Common Raven Corvus corax Linnaeus	3	4	0	0	0	1	0	0	0	3	3	8
Black-capped Chickadee Parus atricapillus	35	20	17	16	17	25	18	24	19	28	106	113
Boreal Chickadee Parus hudsonicus	2	0	0	0	2	1	2	0	0	0	6	1
Red-breasted Nuthatch Sitta canadensis	23	14	1	3	15	19	22	9	14	9	75	54
White-breasted Nuthatch Sitta carolinensis	1	3	1	0	2	4	1	1	0	3	5	11
Brown Creeper Certhia americana	0	0	4	4	12	12	6	16	14	19	36	51
House Wren Troglodytes aedon	2	0	0	0	0	0	0	0	0	0	2	0
Winter Wren Troglodytes troglodytes	9	33	31	23	34	46	19	14	29	37	122	153
Sedge Wren Cistothorus platensis	11	0	2	0	4	0	2	0	0	0	19	0
Marsh Wren Cistothorus palustris	0	0	0	0	0	0	0	0	2	0	2	0
Golden-crowned Kinglet Regulus satrapa	7	0	37	14	26	23	6	11	29	16	105	64
Ruby-crowned Kinglet Regulus calendula	2	0	2	0	0	0	2	1	2	2	8	3
Eastern Bluebird Sialia sialis	0	0	0	0	2	0	0	0	0	0	2	0
Veery Catharus fuscescens	5	13	4	22	21	13	12	12	14	5	56	65
Swainson's Thrush Catharus ustulatus	0	6	0	0	0	0	0	0	0	0	0	6
Hermit Thrush Catharus guttatus	33	31	43	27	62	50	23	38	57	63	218	209
Wood Thrush Hylocichla mustelina	0	0	1	0	0	0	0	2	0	1	1	3
American Robin Turdus migratorius	43	11	16	8	17	34	9	7	6	12	91	72

Appendix 4b (continued)

	1985 T	1985 C	1986 T	1986 C	1987 T	1987 C	1988 T	1988 C	1989 T	1989 C	All years T	All years C
Gray Catbird <u>Dumetella carolinensis</u>	0	0	1	1	4	0	2	1	0	0	7	2
Brown Thrasher <u>Toxostoma rufum</u>	1	1	0	0	0	0	0	0	0	1	1	2
Cedar Waxwing <u>Bombycilla cedrorum</u>	7	1	2	3	3	8	0	2	3	12	15	26
Solitary Vireo <u>Vireo solitarius</u>	13	8	0	1	4	5	7	3	5	1	29	18
Yellow-throated Vireo <u>Vireo flavifrons</u>	0	0	0	1	2	1	2	0	0	0	4	2
Philadelphia Vireo <u>Vireo philadelphicus</u>	2	0	0	0	0	0	1	0	0	0	3	0
Red-eyed Vireo <u>Vireo olivaceus</u>	200	184	101	108	80	104	60	62	85	111	526	569
Golden-winged Warbler <u>Vermivora chrysoptera</u>	6	7	5	1	6	2	5	3	6	6	28	19
Tennessee Warbler <u>Vermivora peregrina</u>	0	0	0	0	2	3	0	0	1	1	3	4
Orange-crowned Warbler <u>Vermivora celata</u>	0	0	0	0	0	0	0	1	0	0	0	1
Nashville Warbler <u>Vermivora ruficapilla</u>	186	127	128	107	136	118	41	58	58	80	549	490
Northern Parula <u>Parula americana</u>	13	22	17	23	18	25	16	16	13	18	77	104
Yellow Warbler <u>Dendroica petechia</u>	9	1	2	1	6	4	2	0	3	0	22	6
Chestnut-sided Warbler <u>Dendroica pensylvanica</u>	85	41	73	57	100	69	78	53	74	54	410	274
Magnolia Warbler <u>Dendroica magnolia</u>	15	6	2	1	4	1	3	0	4	5	28	13
Cape May Warbler <u>Dendroica tigrina</u>	15	17	5	1	2	2	1	1	1	0	24	21
Black-throated Blue Warbler <u>Dendroica caerulescens</u>	1	4	0	1	0	0	0	0	0	0	1	5
Yellow-rumped Warbler <u>Dendroica coronata</u>	21	7	8	3	10	16	15	7	21	4	75	37
Black-throated Green Warbler <u>Dendroica virens</u>	107	125	59	40	72	80	44	56	50	61	332	362

Appendix 4b (continued)

	1985		1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C	T	C
Blackburnian Warbler *Dendroica fusca*	7	9	26	23	27	27	3	13	15	19	78	91
Pine Warbler *Dendroica pinus*	4	0	2	2	2	0	1	0	0	1	9	3
Palm Warbler *Dendroica palmarum*	6	3	8	0	7	1	4	0	2	0	27	4
Black-and-white Warbler *Mniotilta varia*	35	35	25	29	39	38	28	23	22	26	149	151
American Redstart *Setophaga ruticilla*	5	2	1	3	0	5	3	0	4	1	13	11
Ovenbird *Seiurus aurocapillus*	294	246	187	202	126	204	83	127	125	170	815	949
Northern Waterthrush *Seiurus noveboracensis*	1	3	0	2	1	3	1	2	3	0	6	10
Connecticut Warbler *Oporornis agilis*	8	4	4	0	4	2	3	0	2	2	21	8
Mourning Warbler *Oporornis philadelphia*	28	29	22	19	32	25	23	19	35	22	140	114
Common Yellowthroat *Geothylpis trichas*	44	23	27	14	43	28	23	26	15	8	152	99
Canada Warbler *Wilsonia canadensis*	2	9	9	25	9	18	9	8	14	12	43	72
Scarlet Tanager *Piranga olivacea*	4	5	9	8	11	13	5	8	4	3	33	37
Rose-breasted Grosbeak *Pheucticus ludovicianus*	18	16	9	27	23	24	14	12	8	15	72	94
Indigo Bunting *Passerina cyanea*	3	0	15	1	9	0	6	0	10	1	43	2
Rufous-sided Towhee *Pipilo erythrophthalmus*	0	0	0	0	0	0	0	0	1	0	1	0
Chipping Sparrow *Spizella passerina*	22	5	30	5	24	1	15	2	14	1	105	14
Savannah Sparrow *Passerculus sandwichensis*	0	2	0	0	0	0	0	0	0	0	0	2
Song Sparrow *Melospiza melodia*	12	6	24	18	28	27	21	10	13	13	98	74
Lincoln's Sparrow *Melospiza lincolnii*	7	0	5	0	4	0	1	0	0	0	17	0

Appendix 4b (continued)

	1985		1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C	T	C
Swamp Sparrow Melospiza georgianna	14	2	18	2	11	1	10	1	8	1	61	7
White-throated Sparrow Zonotrichia albicollis	54	38	106	80	130	132	60	53	54	49	404	352
Dark-eyed Junco Junco hyemalis	1	1	0	0	4	0	2	1	0	8	7	10
Brewer's Blackbird Euphagus carolinus	0	0	0	0	0	0	0	3	0	0	0	3
Red-winged Blackbird Agelaius phoeniceus	5	1	8	1	10	9	3	2	6	6	32	19
Common Grackle Quiscalus quiscula	0	0	1	8	3	0	10	0	0	5	14	13
Brown-headed Cowbird Molothrus ater	2	1	2	1	1	4	1	1	1	3	7	10
Northern Oriole Icterus galbula	0	0	1	0	0	0	0	0	0	0	1	0
Purple Finch Carpodacus purpureus	4	4	5	2	5	8	0	7	2	2	16	23
Red Crossbill Loxia curvirostra	10	3	0	0	0	0	0	0	0	0	10	3
Pine Siskin Carduelis pinus	5	0	1	0	0	0	0	0	0	0	6	0
American Goldfinch Carduelis tristis	3	2	1	1	1	3	1	5	5	9	11	20
Evening Grosbeak Coccothraustes vespertinus	13	1	0	0	3	0	0	0	0	2	16	3
Unidentified duck	0	0	0	0	0	0	0	1	0	0	0	1
Unidentified passerine	1	2	37	18	51	65	9	12	20	7	118	104
Unidentified woodpecker	0	0	0	5	9	18	10	6	4	5	23	34
Unidentified sparrow	0	0	0	0	0	0	1	0	0	0	1	0
Total individuals	1654	1395	1291	1110	1455	1523	871	894	1042	1084	6313	6006
Total species	77	66	68	58	71	66	69	63	66	67	94	89

Appendix 4c. Total number of individuals and species observed on control (C) and treatment (T) transects in Wisconsin during four years in July. English and scientific names follow AOU (1983, 1985).

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Common Loon Gavia immer	0	1	3	0	0	0	0	0	3	1
Pied-billed Grebe Podilymbus podiceps	0	0	0	1	0	0	0	0	0	1
American Bittern Botaurus lentiginosus	0	0	0	0	1	0	0	0	1	0
Great Blue Heron Ardea herodias	0	0	1	1	1	0	0	0	2	1
Wood Duck Aix sponsa	0	0	0	1	0	0	0	9	0	10
Sharp-shinned Hawk Accipiter striatus	0	0	0	0	2	1	2	0	4	1
Northern Harrier Circus cyaneus	0	0	0	0	1	0	0	0	1	0
Broad-winged Hawk Buteo platypterus	0	4	3	1	0	2	0	2	3	9
Red-tailed Hawk Buteo jamaicensis	0	0	1	0	2	2	0	0	3	2
Spruce Grouse Dendragapus canadensis	0	1	0	0	0	0	0	0	0	1
Ruffed Grouse Bonasa umbellus	8	22	3	2	10	20	5	13	26	57
American Woodcock Scolopax minor	0	1	0	2	0	3	0	0	0	6
Barred Owl Strix varia	0	3	0	0	0	0	0	0	0	3
Chimney Swift Chaetura pelagica	0	0	0	0	0	3	0	0	0	3

Appendix 4c (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Ruby-throated Hummingbird *Archilochus colubris*	0	0	0	1	1	0	0	0	1	1
Belted Kingfisher *Ceryle alcyon*	0	1	0	2	0	1	0	1	0	5
Yellow-bellied Sapsucker *Sphyrapicus varius*	11	9	2	2	5	6	1	2	19	19
Downy Woodpecker *Picoides pubescens*	4	3	5	11	0	1	0	4	9	19
Hairy Woodpecker *Picoides villosus*	0	5	1	1	3	2	0	2	4	10
Black-backed Woodpecker *Picoides arcticus*	0	0	1	0	0	0	0	0	1	0
Northern Flicker *Colaptes auratus*	17	17	9	10	6	2	6	2	38	31
Pileated Woodpecker *Dryocopus pileatus*	0	0	1	4	0	1	1	2	2	7
Olive-sided Flycatcher *Contopus borealis*	1	4	2	1	1	4	2	5	6	14
Eastern Wood-Pewee *Contopus virens*	7	14	2	7	3	13	2	8	14	42
Yellow-bellied Flycatcher *Empidonax flaviventris*	21	23	7	9	15	17	23	21	66	70
Acadian Flycatcher *Empidonax virescens*	0	0	0	0	0	1	0	0	0	1
Alder Flycatcher *Empidonax alnorum*	16	0	7	0	0	0	3	0	26	0
Least Flycatcher *Empidonax minimus*	0	0	3	13	14	8	3	1	20	22
Great Crested Flycatcher *Myiarchus crinitus*	4	3	1	6	0	3	0	1	5	13
Eastern Kingbird *Tyrannus tyrannus*	1	1	1	2	1	3	2	3	5	9

Appendix 4c (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Tree Swallow Tachycineta bicolor	0	0	0	0	0	2	0	3	0	5
Gray Jay Perisoreus canadensis	3	2	9	5	9	1	1	0	22	8
Blue Jay Cyanocitta cristata	15	43	32	24	12	26	11	15	70	108
American Crow Corvus brachyrhynchos	1	0	10	0	0	1	0	0	11	1
Common Raven Corvus corax Linnaeus	1	0	1	0	1	1	0	1	3	2
Black-capped Chickadee Parus atricapillus	62	68	63	70	42	72	87	45	254	255
Boreal Chickadee Parus hudsonicus	9	4	6	3	0	0	0	1	15	8
Red-breasted Nuthatch Sitta canadensis	26	15	49	24	21	34	13	8	109	81
White-breasted Nuthatch Sitta carolinensis	0	3	5	8	0	5	0	1	5	17
Brown Creeper Certhia americana	4	5	4	11	7	10	8	12	23	38
Winter Wren Troglodytes troglodytes	25	29	15	26	15	21	25	33	80	109
Sedge Wren Cistothorus platensis	10	0	1	0	1	0	3	0	15	0
Marsh Wren Cistothorus palustris	0	0	2	0	0	0	0	0	2	0
Golden-crowned Kinglet Regulus satrapa	46	23	41	25	16	15	42	23	145	86
Ruby-crowned Kinglet Regulus calendula	0	0	0	4	0	0	0	0	0	4
Eastern Bluebird Sialia sialis	0	0	2	0	0	0	0	0	2	0

Appendix 4c (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Veery Catharus fuscescens	0	1	3	2	10	6	2	3	15	12
Swainson's Thrush Catharus ustulatus	0	0	0	1	0	0	0	0	0	1
Hermit Thrush Catharus guttatus	60	45	88	60	67	59	94	80	309	244
American Robin Turdus migratorius	8	5	14	10	9	13	4	6	35	34
Gray Catbird Dumetella carolinensis	0	0	0	0	1	2	0	1	1	3
Cedar Waxwing Bombycilla cedrorum	7	4	14	26	3	2	16	15	40	47
Solitary Vireo Vireo solitarius	1	1	3	2	4	4	0	3	8	10
Yellow-throated Vireo Vireo flavifrons	3	1	1	0	0	0	0	0	4	1
Philadelphia Vireo Vireo philadelphicus	0	0	0	1	0	0	0	0	0	1
Red-eyed Vireo Vireo olivaceus	132	125	85	104	63	84	75	96	355	409
Golden-winged Warbler Vermivora chrysoptera	0	0	0	0	0	1	0	1	0	2
Nashville Warbler Vermivora ruficapilla	13	10	8	10	8	18	55	27	84	65
Northern Parula Parula americana	0	0	0	3	5	3	2	3	7	9
Yellow Warbler Dendroica petechia	0	0	0	1	0	0	0	1	0	2
Chestnut-sided Warbler Dendroica pensylvanica	10	4	15	5	30	4	19	[illegible]	74	19
Magnolia Warbler Dendroica magnolia	2	0	0	1	0	2	6	2	8	5

Appendix 4c (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Cape May Warbler Dendroica tigrina	0	0	2	0	0	0	0	0	2	0
Black-throated Blue Warbler Dendroica caerulescens	0	0	0	1	0	0	0	0	0	1
Yellow-rumped Warbler Dendroica coronata	15	4	8	1	10	5	9	2	42	12
Black-throated Green Warbler Dendroica virens	29	28	30	36	50	43	36	38	145	145
Blackburnian Warbler Dendroica fusca	2	1	3	1	2	5	0	0	7	7
Pine Warbler Dendroica pinus	0	0	2	1	0	0	0	0	2	1
Palm Warbler Dendroica palmarum	0	0	1	2	1	0	1	1	3	3
Black-and-white Warbler Mniotilta varia	9	3	2	1	8	0	6	3	25	7
American Redstart Setophaga ruticilla	0	0	2	1	0	0	1	0	3	1
Ovenbird Seiurus aurocapillus	15	33	25	41	28	37	49	65	117	176
Northern Waterthrush Seiurus noveboracensis	0	2	0	0	0	0	0	0	0	2
Connecticut Warbler Oporornis agilis	0	1	1	1	0	0	1	0	2	2
Mourning Warbler Oporornis philadelphia	4	5	10	2	6	1	12	5	32	13
Common Yellowthroat Geothylpis trichas	36	25	31	28	38	25	26	16	131	94
Canada Warbler Wilsonia canadensis	6	6	1	2	1	1	0	1	8	10
Scarlet Tanager Piranga olivacea	1	1	1	0	0	1	2	5	4	7

Appendix 4c (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Rose-breasted Grosbeak <u>Pheucticus</u> <u>ludovicianus</u>	1	0	3	1	3	6	4	9	11	16
Indigo Bunting <u>Passerina</u> <u>cyanea</u>	1	1	2	0	8	0	16	1	27	2
Chipping Sparrow <u>Spizella</u> <u>passerina</u>	9	2	3	6	8	0	7	0	27	8
Lark Sparrow <u>Chondestes</u> <u>grammacus</u>	0	0	2	0	0	0	0	0	2	0
Song Sparrow <u>Melospiza</u> <u>melodia</u>	19	19	15	11	9	13	17	9	60	52
Lincoln's Sparrow <u>Melospiza</u> <u>lincolnii</u>	4	0	2	0	3	0	3	0	12	0
Swamp Sparrow <u>Melospiza</u> <u>georgianna</u>	25	3	6	3	7	0	21	2	59	8
White-throated Sparrow <u>Zonotrichia</u> <u>albicollis</u>	73	122	66	61	63	59	67	45	269	287
Dark-eyed Junco <u>Junco</u> <u>hyemalis</u>	6	2	0	2	4	0	0	0	10	4
Red-winged Blackbird <u>Agelaius</u> <u>phoeniceus</u>	0	3	1	0	1	1	0	0	2	4
Common Grackle <u>Quiscalus</u> <u>quiscula</u>	1	0	0	0	0	1	2	0	3	1
Northern Oriole <u>Icterus</u> <u>galbula</u>	0	2	0	0	0	0	1	1	1	3
Purple Finch <u>Carpodacus</u> <u>purpureus</u>	0	2	1	0	0	0	1	0	2	2
White-winged Crossbill <u>Loxia</u> <u>leucoptera</u>	0	0	29	7	0	0	10	19	39	26
Pine Siskin <u>Carduelis</u> <u>pinus</u>	0	0	0	3	0	0	0	0	0	3
American Goldfinch <u>Carduelis</u> <u>tristis</u>	9	5	14	2	5	5	3	3	31	15

Appendix 4c (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Evening Grosbeak <u>Coccothraustes</u> <u>vespertinus</u>	1	0	5	0	1	6	0	0	7	6
Unidentified non-passerine	0	0	1	0	0	0	0	0	1	0
Unidentified passerine	95	71	102	69	47	35	37	32	281	207
Unidentified woodpecker	3	5	6	9	3	12	4	8	16	34
Total individuals	892	846	901	795	696	735	849	727	3338	3103
Total species	50	55	68	64	54	57	50	55	78	85

Appendix 4d. Total number of individuals and species observed on control (C) and treatment (T) transects in Wisconsin during four years in August. English and scientific names follow AOU (1983, 1985).

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Common Loon _Gavia immer_	1	0	0	0	0	3	0	0	1	3
Great Blue Heron _Ardea herodias_	0	0	0	0	0	1	0	1	0	2
Wood Duck _Aix sponsa_	0	0	0	2	0	0	0	0	0	2
Sharp-shinned Hawk _Accipiter striatus_	0	0	1	1	1	0	0	0	2	1
Cooper's Hawk _Accipiter cooperii_	0	0	1	0	0	0	0	0	1	0
Broad-winged Hawk _Buteo platypterus_	2	0	1	3	1	0	0	0	4	3
Red-tailed Hawk _Buteo jamaicensis_	0	0	1	0	2	2	0	0	3	2
Ruffed Grouse _Bonasa umbellus_	7	7	12	21	11	15	2	1	32	44
Solitary Sandpiper _Tringa solitaria_	0	0	0	0	0	2	0	0	0	2
American Woodcock _Scolopax minor_	1	1	2	5	3	1	1	2	7	9
Barred Owl _Strix varia_	0	0	0	0	0	0	1	0	1	0
Ruby-throated Hummingbird _Archilochus colubris_	0	0	0	1	1	1	0	0	1	2
Belted Kingfisher _Ceryle alcyon_	0	0	0	1	0	1	1	3	1	5
Yellow-bellied Sapsucker _Sphyrapicus varius_	2	10	1	4	4	4	3	1	10	19

Appendix 4d (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Downy Woodpecker _Picoides pubescens_	9	4	5	3	3	2	2	1	19	1
Hairy Woodpecker _Picoides villosus_	2	3	10	4	6	8	3	8	21	23
Black-backed Woodpecker _Picoides arcticus_	0	0	1	0	2	2	1	0	4	2
Northern Flicker _Colaptes auratus_	6	7	8	6	6	3	2	2	22	18
Pileated Woodpecker _Dryocopus pileatus_	1	1	1	3	0	2	1	1	3	7
Olive-sided Flycatcher _Contopus borealis_	0	0	0	0	0	0	0	1	0	1
Eastern Wood-Pewee _Contopus virens_	0	4	2	4	7	11	3	11	12	30
Yellow-bellied Flycatcher _Empidonax flaviventris_	0	0	0	4	1	1	4	1	5	6
Acadian Flycatcher _Empidonax virescens_	0	2	0	0	1	0	1	0	2	2
Alder Flycatcher _Empidonax alnorum_	0	2	0	0	1	0	1	0	2	2
Least Flycatcher _Empidonax minimus_	0	1	0	0	1	1	0	1	1	3
Eastern Phoebe _Sayornis phoebe_	0	0	1	0	0	0	0	0	1	0
Great Crested Flycatcher _Myiarchus crinitus_	0	0	0	1	0	3	0	0	0	4
Eastern Kingbird _Tyrannus tyrannus_	2	0	0	0	5	2	0	0	7	2
Gray Jay _Perisoreus canadensis_	3	2	4	1	2	0	3	4	12	7
Blue Jay _Cyanocitta cristata_	35	29	38	48	22	27	9	22	104	126

Appendix 4d (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
American Crow Corvus brachyrhynchos	2	0	0	4	1	0	0	0	3	4
Common Raven Corvus corax Linnaeus	1	0	0	3	0	0	0	0	1	3
Black-capped Chickadee Parus atricapillus	66	94	82	121	83	97	94	93	325	405
Boreal Chickadee Parus hudsonicus	3	1	5	1	0	1	1	0	9	3
Red-breasted Nuthatch Sitta canadensis	23	21	66	87	26	25	31	29	146	162
White-breasted Nuthatch Sitta carolinensis	1	3	0	2	2	3	1	5	4	13
Brown Creeper Certhia americana	12	22	8	16	9	32	10	13	39	83
Winter Wren Troglodytes troglodytes	4	7	8	3	2	3	10	7	24	20
Sedge Wren Cistothorus platensis	2	0	0	0	5	0	0	0	7	0
Golden-crowned Kinglet Regulus satrapa	59	35	89	47	29	12	46	38	223	132
Ruby-crowned Kinglet Regulus calendula	0	0	6	20	0	0	0	0	6	20
Eastern Bluebird Sialia sialis	0	0	2	0	0	0	0	0	2	0
Veery Catharus fuscescens	0	0	0	1	2	2	0	3	2	6
Swainson's Thrush Catharus ustulatus	0	0	1	0	0	0	0	0	1	0
Hermit Thrush Catharus guttatus	14	5	17	10	12	7	10	11	53	33
American Robin Turdus migratorius	6	3	8	6	6	4	7	5	27	18

Appendix 4d (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Gray Catbird Dumetella carolinensis	0	0	0	3	1	2	2	0	3	5
Cedar Waxwing Bombycilla cedrorum	0	1	35	57	5	32	43	23	83	113
Solitary Vireo Vireo solitarius	0	0	1	1	0	0	3	0	4	1
Red-eyed Vireo Vireo olivaceus	18	29	11	25	10	15	34	37	73	106
Tennessee Warbler Vermivora peregrina	0	0	0	0	0	0	3	0	3	0
Nashville Warbler Vermivora ruficapilla	21	5	8	7	2	1	5	3	36	16
Northern Parula Parula americana	0	0	0	0	0	0	0	2	0	2
Yellow Warbler Dendroica petechia	0	0	0	0	1	0	1	0	2	0
Chestnut-sided Warbler Dendroica pensylvanica	4	5	5	2	0	2	0	5	9	14
Magnolia Warbler Dendroica magnolia	0	0	3	0	0	0	0	0	3	0
Yellow-rumped Warbler Dendroica coronata	26	28	17	0	12	3	0	2	55	33
Black-throated Green Warbler Dendroica virens	6	13	11	0	3	6	3	6	23	25
Blackburnian Warbler Dendroica fusca	0	0	1	0	0	0	0	0	1	0
Palm Warbler Dendroica palmarum	5	0	0	0	3	0	0	0	8	0
Bay-breasted Warbler Dendroica castanea	1	0	2	2	0	0	0	0	3	2
Black-and-white Warbler Mniotilta varia	2	2	2	2	3	3	3	4	10	11

Appendix 4d (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
American Redstart <u>Setophaga</u> <u>ruticilla</u>	3	2	1	0	0	0	0	1	4	3
Ovenbird <u>Seiurus</u> <u>aurocapillus</u>	46	35	13	9	24	27	18	24	101	95
Connecticut Warbler <u>Oporornis</u> <u>agilis</u>	0	0	0	0	1	0	0	0	1	0
Mourning Warbler <u>Oporornis</u> <u>philadelphia</u>	0	0	0	2	4	2	3	0	7	4
Common Yellowthroat <u>Geothylpis</u> <u>trichas</u>	10	4	4	9	1	1	9	3	24	17
Canada Warbler <u>Wilsonia</u> <u>canadensis</u>	8	1	1	2	1	2	2	5	12	10
Rose-breasted Grosbeak <u>Pheucticus</u> <u>ludovicianus</u>	0	1	2	4	7	0	5	1	14	6
Indigo Bunting <u>Passerina</u> <u>cyanea</u>	0	0	0	0	0	1	4	0	4	1
Rufous-sided Towhee <u>Pipilo</u> <u>erythrophthalmus</u>	0	0	0	1	0	0	0	0	0	1
Chipping Sparrow <u>Spizella</u> <u>passerina</u>	1	0	0	0	0	1	0	0	1	1
Song Sparrow <u>Melospiza</u> <u>melodia</u>	3	1	9	1	4	0	9	1	25	3
Swamp Sparrow <u>Melospiza</u> <u>georgianna</u>	6	3	2	0	2	0	0	0	10	3
White-throated Sparrow <u>Zonotrichia</u> <u>albicollis</u>	27	45	21	11	6	14	23	13	77	83
Dark-eyed Junco <u>Junco</u> <u>hyemalis</u>	0	3	1	1	0	0	0	0	1	4
Northern Oriole <u>Icterus</u> <u>galbula</u>	0	0	0	0	0	0	3	0	3	0
Purple Finch <u>Carpodacus</u> <u>purpureus</u>	0	0	0	1	0	0	1	0	1	1

Appendix 4d (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
White-winged Crossbill *Loxia leucoptera*	0	0	1	3	0	0	7	9	8	12
Pine Siskin *Carduelis pinus*	0	0	1	0	0	0	0	4	1	4
American Goldfinch *Carduelis tristis*	10	1	1	2	2	4	7	4	20	11
Evening Grosbeak *Coccothraustes vespertinus*	0	0	7	7	2	0	0	0	9	7
Unidentified passerine	78	54	97	104	73	98	63	54	311	310
Unidentified woodpecker	3	10	1	14	8	6	3	5	15	35
Total individuals	542	507	639	703	432	498	502	470	2115	2178
Total species	41	39	51	51	50	46	46	42	75	69

Appendix 4e. Total number of individuals and species observed on control (C) and treatment (T) transects in Wisconsin during four years in September. English and scientific names follow AOU (1983, 1985).

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Pied-billed Grebe *Podilymbus podiceps*	0	2	0	2	0	0	0	0	0	4
Great Blue Heron *Ardea herodias*	0	1	0	0	0	0	0	1	0	2
Wood Duck *Aix sponsa*	0	3	0	10	0	3	0	2	0	18
Sharp-shinned Hawk *Accipiter striatus*	0	1	0	0	0	2	0	0	0	3
Broad-winged Hawk *Buteo platypterus*	0	0	0	2	0	1	0	1	0	4
Red-tailed Hawk *Buteo jamaicensis*	0	0	0	0	1	0	0	1	1	1
Spruce Grouse *Dendragapus canadensis*	0	0	1	0	0	0	0	0	1	0
Ruffed Grouse *Bonasa umbellus*	7	22	8	19	10	27	8	17	33	85
Common Snipe *Gallinago gallinago*	0	0	1	0	0	0	0	0	1	0
American Woodcock *Scolopax minor*	0	1	2	2	2	1	0	2	4	6
Yellow-billed Cuckoo *Coccyzus americanus*	0	0	0	0	0	0	4	0	4	0
Mourning Dove *Zenaida macroura*	0	0	1	0	0	0	0	0	1	0
Great Horned Owl *Bubo virginianus*	0	0	0	0	0	1	0	0	0	1
Barred Owl *Strix varia*	0	1	0	2	2	0	0	2	2	5
Belted Kingfisher *Ceryle alcyon*	0	1	0	1	0	2	1	0	1	4

Appendix 4e (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Yellow-bellied Sapsucker <u>Sphyrapicus</u> <u>varius</u>	8	10	6	13	0	8	5	11	19	42
Downy Woodpecker <u>Picoides</u> <u>pubescens</u>	9	13	7	7	2	2	2	16	20	38
Hairy Woodpecker <u>Picoides</u> <u>villosus</u>	5	3	8	8	8	4	5	4	26	19
Black-backed Woodpecker <u>Picoides</u> <u>arcticus</u>	0	0	0	0	0	0	0	1	0	1
Northern Flicker <u>Colaptes</u> <u>auratus</u>	4	4	7	8	6	4	6	5	23	21
Pileated Woodpecker <u>Dryocopus</u> <u>pileatus</u>	2	0	0	0	0	1	2	1	4	2
Olive-sided Flycatcher <u>Contopus</u> <u>borealis</u>	0	0	0	1	0	0	0	0	0	1
Eastern Wood-Pewee <u>Contopus</u> <u>virens</u>	0	1	0	0	0	0	1	6	1	7
Gray Jay <u>Perisoreus</u> <u>canadensis</u>	5	1	12	4	4	3	3	5	24	13
Blue Jay <u>Cyanocitta</u> <u>cristata</u>	15	17	40	59	34	57	33	49	122	182
American Crow <u>Corvus</u> <u>brachyrhynchos</u>	8	0	3	0	0	1	0	0	11	1
Common Raven <u>Corvus</u> <u>corax</u> <u>Linnaeus</u>	2	1	1	0	1	0	0	0	4	1
Black-capped Chickadee <u>Parus</u> <u>atricapillus</u>	138	134	118	158	95	102	111	103	462	497
Boreal Chickadee <u>Parus</u> <u>hudsonicus</u>	4	1	2	2	1	3	2	0	9	6
Red-breasted Nuthatch <u>Sitta</u> <u>canadensis</u>	63	55	163	196	6	10	206	192	438	453
White-breasted Nuthatch <u>Sitta</u> <u>carolinensis</u>	0	7	1	7	3	4	2	6	6	24

Appendix 4e (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Brown Creeper Certhia americana	6	11	20	24	10	15	22	25	58	75
Winter Wren Troglodytes troglodytes	4	5	10	15	4	8	4	4	22	32
Sedge Wren Cistothorus platensis	3	0	0	0	0	0	0	0	3	0
Golden-crowned Kinglet Regulus satrapa	34	38	48	32	30	16	41	22	153	108
Ruby-crowned Kinglet Regulus calendula	18	8	3	3	10	3	3	0	34	14
Gray-cheeked Thrush Catharus minimus	2	0	4	0	0	0	0	0	6	0
Swainson's Thrush Catharus ustulatus	1	0	0	1	0	0	5	4	6	5
Hermit Thrush Catharus guttatus	14	9	15	11	2	7	11	14	42	41
American Robin Turdus migratorius	18	10	3	13	7	7	0	0	28	30
Gray Catbird Dumetella carolinensis	0	0	0	0	0	1	0	0	0	1
Cedar Waxwing Bombycilla cedrorum	0	0	3	5	0	0	7	4	10	9
Solitary Vireo Vireo solitarius	0	0	0	1	2	1	1	2	3	4
Warbling Vireo Vireo gilvus	0	0	0	0	0	1	0	0	0	1
Red-eyed Vireo Vireo olivaceus	1	0	5	5	2	3	11	6	19	14
Tennessee Warbler Vermivora peregrina	1	0	1	0	0	0	7	0	9	0
Orange-crowned Warbler Vermivora celata	0	0	0	0	1	0	0	0	1	0

Appendix 4e (continued)

	1986 T	1986 C	1987 T	1987 C	1988 T	1988 C	1989 T	1989 C	All years T	All years C
Nashville Warbler Vermivora ruficapilla	1	0	0	1	2	2	13	2	16	5
Chestnut-sided Warbler Dendroica pensylvanica	0	0	1	0	0	0	6	3	7	3
Magnolia Warbler Dendroica magnolia	0	2	3	2	1	1	1	1	5	6
Black-throated Blue Warbler Dendroica caerulescens	0	1	0	0	0	0	0	0	0	1
Yellow-rumped Warbler Dendroica coronata	199	105	81	93	54	30	42	10	376	238
Black-throated Green Warbler Dendroica virens	3	6	1	7	7	1	7	8	18	22
Blackburnian Warbler Dendroica fusca	0	0	0	0	1	0	1	1	2	1
Pine Warbler Dendroica pinus	27	4	1	5	5	2	9	0	42	11
Bay-breasted Warbler Dendroica castanea	0	0	1	2	0	0	1	0	2	2
Black-and-white Warbler Mniotilta varia	0	0	0	0	0	0	4	3	4	3
American Redstart Setophaga ruticilla	0	0	2	3	2	0	1	1	5	4
Ovenbird Seiurus aurocapillus	0	2	18	15	1	7	21	46	40	70
Northern Waterthrush Seiurus noveboracensis	0	1	0	0	0	0	1	1	1	2
Common Yellowthroat Geothylpis trichas	4	0	6	2	0	1	9	3	19	6
Canada Warbler Wilsonia canadensis	0	0	0	0	1	0	0	1	1	1
Rose-breasted Grosbeak Pheucticus ludovicianus	0	0	1	2	0	1	4	1	5	4

Appendix 4e (continued)

	1986		1987		1988		1989		All years	
	T	C	T	C	T	C	T	C	T	C
Rufous-sided Towhee <u>Pipilo</u> <u>erythrophthalmus</u>	0	0	0	0	0	0	3	0	3	0
Chipping Sparrow <u>Spizella</u> <u>passerina</u>	0	0	0	0	0	0	2	0	2	0
Fox Sparrow <u>Passerella</u> <u>iliaca</u>	0	0	1	0	0	0	0	0	1	0
Song Sparrow <u>Melospiza</u> <u>melodia</u>	2	0	1	4	2	2	1	4	6	10
Swamp Sparrow <u>Melospiza</u> <u>georgianna</u>	11	0	4	0	2	1	3	0	20	1
White-throated Sparrow <u>Zonotrichia</u> <u>albicollis</u>	44	72	120	66	31	38	38	28	233	204
Dark-eyed Junco <u>Junco</u> <u>hyemalis</u>	6	7	10	17	3	2	0	0	19	26
Common Grackle <u>Quiscalus</u> <u>quiscula</u>	0	0	2	0	0	0	0	0	2	0
Purple Finch <u>Carpodacus</u> <u>purpureus</u>	0	3	0	0	0	0	0	0	0	3
White-winged Crossbill <u>Loxia</u> <u>leucoptera</u>	0	0	1	0	0	0	15	6	16	6
Pine Siskin <u>Carduelis</u> <u>pinus</u>	0	0	10	4	0	0	14	0	24	4
American Goldfinch <u>Carduelis</u> <u>tristis</u>	0	5	1	0	2	3	1	1	4	9
Evening Grosbeak <u>Coccothraustes</u> <u>vespertinus</u>	0	0	9	0	0	0	2	3	11	3
Unidentified passerine	25	78	77	65	65	61	65	48	232	252
Unidentified woodpecker	5	11	2	4	7	9	5	1	19	25
Total individuals	699	657	846	903	429	459	772	678	2746	2697
Total species	33	37	47	42	37	42	48	45	64	64